Public Works and Government Services Canada

Requisition No. EZ899-170892

DRAWINGS AND SPECIFICATIONS
For
HUNTINGDON PORT OF ENTRY, ABBOTSFORD, B.C.
ITF AND CTF BUILDINGS BOILER PLANT REPLACEMENTS

Project No. R.078416.001 April 25, 2016

Issued for Tender

APPROVED BY:

Regional Manager, A&E Services — Date 2016-05-03

Construction Safety Coordinator — Date 2016-05-03

TENDER:

Project Manager — Date May 03, 2016

Real Property Services Branch, Professional and Technical Services, Pacific Region
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DISCIPLINE	SEAL
MECHANICAL ENGINEER	PROFESSIONAL PROVINCE OF S. VUJIC # 30387 BRITISH COLUMBIA ENGINEER April 25, 2016
ELECTRICAL ENGINEER	PROFESSIONAL PROVINCE OF M.J. FERRIE V 31738 BRITISH COLUMBIA ENGINEER April 25, 2016.

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Part 1 General

1.1 CODES

.1 Perform work to CURRENT Codes, Construction Standards and Bylaws, including Amendments up to the TENDER closing date.

1.2 DESCRIPTION OF WORK

.1 Work under this Contract covers ITF & CTF Boiler Plant Replacement at Huntingdon Port of Entry in Abbotsford, BC.

.2 Work to be performed under this Contract includes, but is not limited to, the following items covered further in the Contract documents.

- .1 Installation of two new floor-mounted condensing boilers for each building.
- .2 Removal of seven existing floor-mounted heating boilers, associated flues, and pumps.
- .3 Installation of two new floor-mounted condensing heating boilers and boiler vents.
- .4 Installation of new circulation pumps.
- .5 Adjustment of heating piping in Mechanical room to suit new pump arrangement.
- .6 Installation of primary-secondary header and buffer tank in the existing hydronic distribution system.
- .7 Addition of new control system, for each building, to the existing control system so that the existing systems and new systems shall work in unity without any problem.
- .8 Electrical connections to new equipment and controls systems, for each building.
- .9 Construction of new pad for each building.
- .10 Commissioning for each building.

.3 "Green Requirements:

- .1 Use only environmentally responsible green materials/products with no VOC emissions or minimum VOC emissions of indoor off-gassing contaminants for improved indoor air quality – subject of Departmental Representative's approval of submitted MSDS Product Data.
- .2 Use materials/products containing highest percentage of recycled and recovered materials practicable – consistent with maintaining cost effective satisfactory levels of competition.
- .3 Adhere to waste reduction requirement for reuse or recycling of waste materials, thus diverting materials from landfill.

1.3 CONTRACT DOCUMENTS

.1 The Contract documents, drawings and specifications are intended to complement each other, and to provide for and include everything necessary for the completion of the work.

.2 Drawings are, in general, diagrammatic and are intended to indicate the scope and general arrangement of the work.

1.4 DIVISION OF SPECIFICATIONS

.1 The specifications are subdivided in accordance with the current 6-digit National Master Specifications System.

.2 A division may consist of the work of more than 1 subcontractor. Responsibility for determining which subcontractor provides the labour, material, equipment and services required to complete the work rests solely with the Contractor.

.3 In the event of discrepancies or conflicts when interpreting the drawings and specifications, the specifications govern.

1.5 TIME OF COMPLETION

.1 Complete the ITF and CTF Boiler Plant Replacement project ready for use within 30 weeks after Contract Award.

1.6 HOURS OF WORK

.1 Restrictive as follows:

.1 Normal weekday and weekend working hours of the building are 06:30 to 18:00.

.2 Notify Departmental Representative of all after hours work, including weekends and holidays.

.3 Access to the site will be granted and supervised by the Departmental Representative.

1.7 COST BREAKDOWN

.1 Before submitting the first progress claim, submit a breakdown of the Contract lump sum prices in detail as directed by the Departmental Representative and aggregating Contract price.

1.8 CODES, BYLAWS, STANDARDS

.1 Perform work in accordance with the National Building Code of Canada (NBC) 2015, and other indicated Codes, Construction Standards and/or any other Code or Bylaw of local application.

.2 Comply with applicable local bylaws, rules and regulations enforced at the location concerned.

.3 Meet or exceed requirements of Contract documents, specified standards, codes and referenced documents.

.4 In any case of conflict or discrepancy, the most stringent requirements shall apply.

1.9 DOCUMENTS REQUIRED

.1 Maintain 1 copy each of the following at the job site:

.1 Contract drawings.

.2 Contract specifications.

.3 Addenda to Contract documents.

.4 Copy of approved work schedule.

.5 Reviewed/approved shop drawings.

.6 Change orders.

.7 Other modifications to Contract.

.8 Field test reports.

.9 Reviewed/approved samples.

.10 Manufacturers' installation and application instructions.

.11 One set of record drawings and specifications for "as-built" purposes.

.12 National Building Code of Canada 2015.

.13 Current construction standards of workmanship listed in technical Sections.

.14 Building Safety Plan.

1.10 REGULATORY REQUIREMENTS

.1 Obtain and pay for – Building Permit, Certificates, Licenses and other permit required by regulatory municipal, provincial or federal authorities to complete the work.

.2 Provide inspection authorities with plans and information required for issue of acceptance certificates.

.3 Furnish inspection certificates in evidence that the work installed conforms with the requirements of the authority having jurisdiction.

1.11 CONTRACTOR'S USE OF SITE

.1 Use of site:

.1 Exclusive and complete for execution of work.

.2 Assume responsibility for assigned premises for performance of this work.

.3 Be responsible for coordination of all work activities on site, including the work of other contractors engaged by the Departmental Representative such as moving contractors and furniture installers.

.2 Perform work in accordance with Contract documents. Ensure work is carried out in accordance with indicated phasing.

.3 Do not unreasonably encumber site with material or equipment.

.4 Use only indicated [elevators] for moving workers and material.

.1 Protect walls of passenger elevators, to approval of Departmental Representative prior to use.

.2 Accept liability for damage, safety of equipment and overloading of existing equipment.

1.12 EXAMINATION

.1 Examine site and be familiar and conversant with existing conditions likely to affect work

.2 Provide photographs of surrounding properties, objects and structures liable to be damaged or be the subject of subsequent claims.

1.13 EXISTING SERVICES

.1 Where work involves breaking into or connecting to existing services, carry out work at times directed by the authorities having jurisdiction.

1.14 LOCATION OF EQUIPMENT AND FIXTURES

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

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

.3 Inform Departmental Representative of impending installation and obtain his approval for actual locations.

.4 Submit field drawings or shop drawings to indicate the relative position of various services and equipment when required by the Departmental Representative.

1.15 CUTTING AND PATCHING

.1 Cut existing surfaces as required to accommodate new work.

.2 Remove items so shown or specified.

.3 Do not cut, bore, or sleeve load-bearing members.

.4 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.

.5 Fit work airtight to pipes, sleeves ducts and conduits.

.6 Conceal pipes, ducts and wiring in raised floors, wall and ceiling construction of finished areas except where indicated otherwise.

.7 Patch and make good surfaces cut, damaged or disturbed, to Departmental Representative's approval. Match existing material, colour, finish and texture.

.8 Install firestops and smoke seals in accordance with ULC-S115, around pipe, ductwork, cables and other objects penetrating fire separations to provide fire resistance not less than the fire resistance of surrounding floor, ceiling and wall assembly.

.9 Making good is defined as matching construction and finishing materials and the adjacent surfaces such that there is no visible difference between existing and new surfaces when viewed from 1.5 metres in ambient light, and includes painting the whole surface to the next change in plane.

1.16 SETTING OUT OF WORK

.1 Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.

.2 Provide devices needed to lay out and construct work.

.3 Supply such devices as templates required to facilitate Departmental Representative's inspection of work.

1.17 ACCEPTANCE OF SUBSTRATES

.1 Each trade shall examine surfaces prepared by others and job conditions which may affect his work, and shall report defects to the Departmental Representative. Commencement of work shall imply acceptance of prepared work or substrate surfaces.

1.18 QUALITY OF WORK

.1 Ensure that quality workmanship is performed through use of skilled tradesmen, under supervision of qualified journeyman.

.2 The workmanship, erection methods and procedures to meet minimum standards set out in the National Building Code of Canada 2015 and the British Columbia Building Code 2012.

.3 In cases of dispute, decisions as to standard or quality of work rest solely with the Departmental Representative, whose decision is final.

1.19 WORKS COORDINATION

.1 Coordinate work of subtrades

.1 Designate one person to be responsible for review of contract documents and shop drawings and managing coordination of Work.

.2 Convene meetings between subcontractors whose work interfaces and ensure awareness of areas and extent of interface required.

.1 Provide each subcontractor with complete plans and specifications for Contract, to assist them in planning and carrying out their respective work.

.2 Develop coordination drawings when required, illustrating potential interference between work of various trades and distribute to affected parties.

.1 Pay particular close attention to overhead work above ceilings and within or near to building structural elements.

.2 Identify on coordination drawings, building elements, service lines, rough-in points and indicate location services entrance to site.

.3 Facilitate meeting and review coordination drawings. Ensure subcontractors agree and sign off on drawings.

.4 Publish minutes of each meeting.

.5 Plan and coordinate work in such a way to minimize quantity of service line offsets.

.6 Submit copy of coordination drawings and meeting minutes to Departmental Representative for information purposes.

.3 Submit shop drawings and order of prefabricated equipment or rebuilt components only after coordination meeting for such items has taken place.

.4 Work coordination:

.1 Ensure cooperation between trades in order to facilitate general progress of Work and avoid situations of spatial interference.

.2 Ensure that each trade provides all other trades reasonable opportunity for completion of Work and in such a way as to prevent unnecessary delays, cutting, patching and removal or replacement of completed work.

.3 Ensure disputes between subcontractors are resolved.

.5 Departmental Representative is not responsible for, or accountable for extra costs incurred as a result of Contractor's failure to coordinate Work.

1.20 APPROVAL OF SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

.1 In accordance with Section 013300, submit the requested shop drawings, product data, MSDS sheets and samples indicated in each of the technical Sections.

.2 **Allow sufficient time for the following**:

.1 Review of product data.

.2 Approval of shop drawings.

.3 Review of re-submission.

.4 Ordering of approved material and/or products.

1.21 PROJECT MEETINGS

.1 Departmental Representative will arrange project meetings and assume responsibility for setting times and recording and distributing minutes.

1.22 TESTING AND INSPECTION

.1 Particular requirements for inspection and testing to be carried out by testing service or laboratory approved by the Departmental Representative are specified in relevant specification sections.

.2 The Contractor will appoint and pay for the services of testing agency or testing laboratory as specified, and where required for the following:

.1 Inspection and testing required by laws, ordinances, rules, regulations or orders of public authorities.

.2 Inspection and testing performed exclusively for Contractor's convenience.

.3 Testing, adjustment and balancing of conveying systems, mechanical and electrical equipment and systems:

.1 Mill tests and certificates of compliance.

.2 Tests specified to be carried out by Contractor under the Departmental Representative's supervision.

.3 Where tests or inspections by designated testing laboratory reveal work is not in accordance with the Contract requirements, Contractor shall pay costs for additional tests or inspections as the Departmental Representative may require to verify acceptability of correct work.

.4 Contractor shall furnish labour and facilities to:

.1 Notify Departmental Representative in advance of planned testing.

.5 Where materials are specified to be tested, deliver representative samples in required quantity to testing laboratory.

.6 Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and approved by Departmental Representative.

.7 The Departmental Representative may require, and pay for, additional inspection and testing services not included in Paragraph 27.1.

.8 Provide Departmental Representative with 2 copies of testing laboratory reports as soon as they are available.

1.23 TEMPORARY HEATING

.1 Provide temporary heating and ventilation to the facility if the boiler replacement or system shuts down in the heating season.

1.24 AFTER HOURS WORK

.1 The Contractor shall allow after hours work in the contract price to accommodate the facility operation.

1.25 AS-BUILT DOCUMENTS

.1 The Departmental Representative will provide 2 sets of drawings, 2 sets of specifications, and 2 copies of the original AutoCAD files for "as-built" purposes.

.2 As work progresses, maintain accurate records to show all deviations from the Contract documents. Note on as-built specifications, drawings and shop drawings as changes occur.

.3 Refer to Section 01 78 30.

1.26 CLEANING

.1 Daily conduct cleaning and disposal operations. Comply with local ordinances and anti-pollution laws.

.2 **Ensure cleanup of the work areas each day after completion of work.**

.3 Clean interior building areas when ready to receive finish painting and continue cleaning on an as-needed basis until building is sufficiently completed or ready for occupancy.

.4 In preparation for interim and final inspections:

.1 Examine all sight-exposed interior and exterior surfaced and concealed spaces.

.2 Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces, including glass and other polished surfaces.

.5 Use cleaning materials and methods in accordance with instructions of the manufacturer of the surface to be cleaned.

1.27 DUST CONTROL

.1 Provide temporary dust tight screens or partitions to localize dust generating activities, and for protection of workers, finished areas of work and public.

.2 Protect furnishings within work area with [0.102] mm thick polyethylene film during construction. Remove film during non-construction hours and leave premises in clean, unencumbered and safe manner for normal daytime function.

.3 Maintain and relocate protection until such work is complete.

1.28 ENVIRONMENTAL PROTECTION

.1 Prevent extraneous materials from contaminating air beyond construction area, by providing temporary enclosures during work.

.2 Do not dispose of waste or volatile materials into water courses, storm or sanitary sewers.

.3 Ensure proper disposal procedures in accordance with all applicable territorial regulations.

1.29 MAINTENACE MATERIALS, SPECIAL TOOLS AND SPARE PARTS

.1 Specific requirements for maintenance materials, tools and spare parts are specified in Section 01 78 30.

1.30 ADDITIONAL DRAWINGS

.1 The Departmental Representative may furnish additional drawings for clarification. These additional drawings have the same meaning and intent as if they were included with plans referred to in the Contract documents.

.2 Upon request, Departmental Representative may furnish up to a maximum of 10 sets of Contract documents for use by the Contractor at no additional cost. Should more than 10 sets of documents be required the Departmental Representative will provide them at additional cost.

1.31 BUILDING SMOKING ENVIRONMENT

.1 Smoking within the building is not permitted.

1.32 SYSTEM OF MEASUREMENT

.1 The metric system of measurement (SI) will be employed on this Contract.

1.33 SUBMISSION OF TENDER

.1 Submission of a tender is deemed to be confirmation of the fact that the Tenderer has analyzed the Contract documents and inspected the site, and is fully conversant with all conditions.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

1.1 RESTRICTED OR SECURE AREA

.1 Any area on project property except the area assigned specifically to the Contractor is a secure or restricted area.

1.2 CONTRACTOR'S RESPONSIBILITY

.1 General Contractor and subcontractor shall be responsible for construction, personnel and vehicles employed on project and requiring access to restricted areas.

.2 All Contract personnel and equipment must remain within designated work areas at all times.

.3 Contractors shall be responsible for the security of their own equipment and materials.

1.3 PASSES AND KEYS

.1 Keys necessary for access to restricted areas to be responsibility of Contractor when issued and controlled by the Departmental Representative. All keys will be returned as laid down by the Departmental Representative. Keys not returned or lost shall be subject to a charge of $200.00.

.2 Contractor is responsible for ensuring that the gate is closed and locked after each truck goes through it. This will require that a Contractor's employee be present to open and close the gate when trucks are hauling to the site.

1.4 ESCORT

.1 General

.1 Contractor shall require a qualified escort (Commissionaire) during the work.

.2 The escort will be provided by PWGSC but all related costs for the services of the escort are to be borne by the contractor.

.3 Contractor to show the amount allowed for Commissionaire costs in the cost breakdown to be provided after contract award.

.2 Allowance

.1 The contractor shall allow the following rates for escort services:

.1 Hourly rate of $29.00 per hour for escort services up to 8 hours per day.

.2 Overtime rate of $43.50 shall apply for the services of the escort in excess of 8 hours per day.

.3 Schedule

.1 Contractor shall provide to Departmental Representative a minimum of 48 hour notice in advance of when escort services will be required.

.4 Payment

.1 The cost for the escort will be assessed against the contract by credit change order.

1.5 RESPONSIBLE PERSONNEL

.1 Provide Departmental Representative with a list of responsible personnel, and those of sub- contractors, who may be contacted after working hours in case of emergency.

.2 The Contractor will be responsible for all personnel and vehicles employed by the Contractor as well as personnel and vehicles of a sub-contractor and suppliers of materials or services requiring access to restricted areas.

.3 All security staff employed by the Contractor including the escort must attend a briefing with the security services division prior to the project.

1.6 DAILY SECURITY

.1 Ensure that access to restricted area is secured at end of each work day.

.2 When work is to be done within restricted area after normal working hours, notify Departmental Representative of area and times.

1.7 EVACUATION

.1 The Contractor shall be required to abandon and evacuate the work sites, as directed, should an emergency situation be declared.

1.8 RADIO ESCORT

.1 Any Contractor's employee found outside of the work site limit without an escort will no longer be allowed inside the secure area.

1.9 VEHICLES

.1 Contractors' vehicles shall be removed from the construction site when not actually in use. If contractors' vehicles are left at the site, they are to be stored in a location determined by the Departmental Representative.

END OF SECTION

1.1 APPROVALS

.1 Approval of shop drawings and samples: refer to Section 01 11 55 Part 1.22.

1.2 GENERAL

.1 This Section specifies general requirements and procedures for the Contractor's submissions of shop drawings, product data, samples and other requested submittals to Departmental Representative for review. Additional specific requirements for submissions are specified in individual technical sections.

.2 Present shop drawings, product data and samples in SI Metric units.

.3 Where items or information is not produced in SI Metric units, converted values are acceptable.

.4 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submissions.

.5 Notify Departmental Representative in writing at time of submission, identifying deviations from requirements of Contract documents and stating reasons for deviations.

.6 Contractor's responsibility for deviations in submission from requirements of Contract documents is not relieved by Departmental Representative's review of submission unless Departmental Representative gives written acceptance of specific deviations.

.7 Make any changes in submissions which Departmental Representative may require consistent with Contract documents and resubmit as directed by Departmental Representative.

.8 Notify Departmental Representative in writing, when resubmitting, of any revisions other than those requested by Departmental Representative.

.9 **Do not proceed with work until relevant submissions are reviewed and approved by the Departmental Representative.**

1.3 SUBMISSION REQUIREMENTS

.1 Coordinate each submission with the requirements of the work and the Contract documents. Individual submissions will not be reviewed until all related information is available.

.2 Allow 10 (ten) days for Departmental Representative's review of each submission, unless noted otherwise.

.3 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.

.4 Submissions shall 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 field measurements and compliance with Contract documents.

.5 Details of appropriate portions of work as applicable.

.1 Fabrication.

.2 Layout, showing dimensions (including identified field dimensions: and clearances.

.3 Setting or erection details.

.4 Capacities.

.5 Performance characteristics.

.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.6 After Departmental Representative's review, distribute copies.

1.4 SHOP DRAWINGS

.1 Shop drawings: original drawings or modified standard drawings provided by Contractor to illustrate details of portion of work which are specific to project requirements.

.2 Maximum sheet size: 850 x 1050 mm.

.3 Submit 6 prints of shop drawings for each requirement requested in the specification sections and/or as requested by the Departmental Representative.

.4 Cross-reference shop drawing information to applicable portions of the Contract documents.

1.5 SHOP DRAWINGS REVIEW

.1 Review of shop drawings by Public Works and Government Services Canada is for the sole purpose of ascertaining conformance with the general concept.

.2 This review shall not mean that Public Works and Government Services Canada approves the detail design inherent in the shop drawings, responsibility for which shall remain with Contractor submitting same.

.3 This review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the construction and Contract documents.

.4 Without restricting the generality of the foregoing, the Contractor is responsible for:

.1 Dimensions to be confirmed and correlated at the job site.

.2 Information that pertains solely to fabrication processes or to techniques of construction and installation.

.3 Coordination of the work of all sub-trades.

1.6 PRODUCT DATA

.1 Product data: manufacturers' catalogue sheets, MSDS sheets, brochures, literature, performance charts and diagrams, used to illustrate standard manufactured products or any other specified information.

.2 Delete information not applicable to project.

.3 Supplement standard information to provide details applicable to project.

.4 Cross-reference product data information to applicable portions of Contract documents.

.5 Submit 6 copies of product data.

1.7 SAMPLES

.1 Samples: examples of materials, equipment, quality, finishes and workmanship.

.2 Where colour, pattern or texture is a criterion, submit a full range of samples.

.3 **Reviewed and accepted samples will become the standard of workmanship and material against which installed work will be verified**.

1.8 PROGRESS SCHEDULE

.1 Submit work schedule and cost breakdown as required in Section 01 11 55.

1.9 TEST RESULTS AND INSPECTION REPORTS

.1 Submit in duplicate test results and inspection reports required by following Section 01 11 55.

END OF SECTION

1. REFERENCES

.1 Government of Canada:

- .1 Canada Labour Code – Part II
- .2 Canada Occupational Health and Safety Regulations.

.2 National Building Code of Canada (NBC) 2015:

- .1 Part 8, Safety Measures at Construction and Demolition Sites.

.3 Canadian Standards Association (CSA): as amended:

- .1 CSA Z797-2009 Code of Practice for Access Scaffold.
- .2 CSA S269.1-1975 (R2003) Falsework for Construction Purposes.
- .3 CSA-S350-M1980 (R2003), Code of Practice for Safety in Demolition of Structures.

.4 Fire Protection Engineering Services, HRSDC:

- .1 FCC No. 301, Standard for Construction Operations.
- .2 FCC No. 302, Standard for Welding and Cutting.

.5 American National Standards Institute (ANSI):

- .1 ANSI A10.3, Operations – Safety Requirements for Powder-Actuated Fastening Systems.

.6 Province of British Columbia:

- .1 Workers Compensation Act Part 3 - Occupational Health and Safety.
- .2 Occupational Health and Safety Regulation.

.7 Yukon Territory:

- .1 Occupational Health and Safety Act, R.S.Y.

2. RELATED SECTIONS

.1 Refer to the following current NMS sections as required:

.1	Security:	Section 01 32 19
.2	Shop Drawings, Product Data, and Samples	Section 01 33 00
.3	Health and safety requirements:	Section 01 35 33
.4	Temporary facilities:	Section 01 51 00

3. WORKERS' COMPENSATION BOARD COVERAGE

.1 Comply fully with the Workers' Compensation Act, regulations and orders made pursuant thereto, and any amendments up to the completion of the work.

.2 Maintain Workers' Compensation Board coverage during the term of the Contract, until and including the date that the Certificate of Final Completion is issued.

4. COMPLIANCE WITH REGULATIONS

.1 PWGSC may terminate the Contract without liability to PWGSC where the Contractor, in the opinion of PWGSC, refuses to comply with a requirement of the Workers' Compensation Act or the Occupational Health and Safety Regulations.

.2 It is the Contractor's responsibility to ensure that all workers are qualified, competent and certified to perform the work as required by the Workers' Compensation Act or the Occupational Health and Safety Regulations

5. SUBMITTALS

.1 Submit to Departmental Representative submittals listed for review in accordance with Section 013300.

.2 Work effected by submittal shall not proceed until review is complete.

.3 Submit the following:

- .1 Health and Safety Plan.
- .2 Copies of reports or directions issued by Federal and Provincial health and safety inspectors.
- .3 Copies of incident and accident reports.
- .4 Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Materials Information System (WHMIS) requirements.
- .5 Emergency Procedures.

.4 The Departmental Representative will review the Contractor's site-specific project Health and Safety Plan and emergency procedures, and provide comments to the Contractor within 15 days after receipt of the plan. Revise the plan as appropriate and resubmit to Departmental Representative.

.5 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 to Departmental Representative.

.6 Submission of the Health and Safety Plan, and any revised version, to the Departmental Representative is for information and reference purposes only. It shall not:

- .1 Be construed to imply approval by the Departmental Representative.
- .2 Be interpreted as a warranty of being complete, accurate and legislatively compliant.
- .3 Relieve the Contractor of his legal obligations for the provision of health and safety on the project.

6. 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 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

7. HEALTH AND SAFETY COORDINATOR

.1 The Health and Safety Coordinator must:

.1 Be responsible for completing all health and safety training, and ensuring that personnel that do not successfully complete the required training are not permitted to enter the site to perform work.

.2 Be responsible for implementing, daily enforcing, and monitoring the site-specific Health and Safety Plan.

.3 Be on site during execution of work.

8. GENERAL CONDITIONS

.1 Provide safety barricades and lights around work site as required to provide a safe working environment for workers and protection for pedestrian and vehicular traffic.

.2 Ensure that non-authorized persons are not allowed to circulate in designated construction areas of the work site.

.1 Provide appropriate means by use of barricades, fences, warning signs, traffic control personnel, and temporary lighting as required.

.2 Secure site at night time [or provide security guard] as deemed necessary to protect site against entry.

9. PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:

.1 Departmental Representative.

10. REGULATORY REQUIREMENTS

.1 Comply with specified codes, acts, bylaws, standards and regulations to ensure safe operations at site.

.2 In event of conflict between any provision of the above authorities, the most stringent provision will apply. Should a dispute arise in determining the most stringent requirement, the Departmental Representative will advise on the course of action to be followed.

11. WORK PERMITS

.1 Obtain specialty permits related to project before start of work.

12. FILING OF NOTICE

.1 The General Contractor is to complete and submit a Notice of Project as required by Provincial authorities.

.2 Provide copies of all notices to the Departmental Representative.

13. HEALTH AND SAFETY PLAN

.1 Conduct a site-specific hazard assessment based on review of Contract documents, required work, and project site. Identify any known and potential health risks and safety hazards.

.2 Prepare and comply with a site-specific project Health and Safety Plan based on hazard assessment, including, but not limited to, the following:

- .1 Primary requirements:
  - .1 Contractor's safety policy.
  - .2 Identification of applicable compliance obligations.
  - .3 Definition of responsibilities for project safety/organization chart for project.
  - .4 General safety rules for project.
  - .5 Job-specific safe work, procedures.
  - .6 Inspection policy and procedures.
  - .7 Incident reporting and investigation policy and procedures.
  - .8 Occupational Health and Safety Committee/Representative procedures.
  - .9 Occupational Health and Safety meetings.
  - .10 Occupational Health and Safety communications and record keeping procedures.
- .2 Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations which must be performed as part of the work.
- .3 List hazardous materials to be brought on site as required by work.
- .4 Indicate engineering and administrative control measures to be implemented at the site for managing identified risks and hazards.
- .5 Identify personal protective equipment (PPE) to be used by workers.
- .6 Identify personnel and alternates responsible for site safety and health.
- .7 Identify personnel training requirements and training plan, including site orientation for new workers.

.3 Develop the plan in collaboration with all subcontractors. Ensure that work/activities of subcontractors are included in the hazard assessment and are reflected in the plan.

.4 Revise and update Health and Safety Plan as required, and re-submit to the Departmental Representative.

.5 Departmental Representative's review: the review of Health and Safety Plan by Public Works and Government Services Canada (PWGSC) shall not relieve the Contractor of responsibility for errors or omissions in final Health and Safety Plan or of responsibility for meeting all requirements of construction and Contract documents.

14. EMERGENCY PROCEDURES

.1 List standard operating procedures and measures to be taken in emergency situations. Include an evacuation plan and emergency contacts (i.e. names/telephone numbers) of:

- .1 Designated personnel from own company.

.2 Regulatory agencies applicable to work and as per legislated regulations.

.3 Local emergency resources.

.4 Departmental Representative.

.2 Include the following provisions in the emergency procedures:

.1 Notify workers and the first-aid attendant, of the nature and location of the emergency.

.2 Evacuate all workers safely.

.3 Check and confirm the safe evacuation of all workers.

.4 Notify the fire department or other emergency responders.

.5 Notify adjacent workplaces or residences which may be affected if the risk extends beyond the workplace.

.6 Notify Departmental Representative.

.3 Provide written rescue/evacuation procedures as required for, but not limited to:

.1 Work at high angles.

.2 Work in confined spaces or where there is a risk of entrapment.

.3 Work with hazardous substances.

.4 Underground work.

.5 Work on, over, under and adjacent to water.

.6 Workplaces where there are persons who require physical assistance to be moved.

.4 Design and mark emergency exit routes to provide quick and unimpeded exit.

.5 At least once each year, emergency drills must be held to ensure awareness and effectiveness of emergency exit routes and procedures, and a record of the drills must be kept.

.6 Revise and update emergency procedures as required, and re-submit to the Departmental Representative.

15. HAZARDOUS PRODUCTS

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to the Departmental Representative and in accordance with the Canada Labour Code.

.2 Where use of hazardous and toxic products cannot be avoided:

.1 Advise Departmental Representative beforehand of the product(s) intended for use. Submit applicable MSDS and WHMIS documents as per Section 01 33 00.

.2 In conjunction with Departmental Representative, schedule to carry out work during "off hours" when tenants have left the building.

.3 Provide adequate means of ventilation in accordance with Section 01 51 00.

16. ELECTRICAL SAFETY REQUIREMENTS

.1 Comply with authorities and ensure that, when installing new facilities or modifying existing facilities, all electrical personnel are completely familiar with existing and new electrical circuits and equipment and their operation.

.1 Before undertaking any work, coordinate required energizing and de-energizing of new and existing circuits with Departmental Representative.

.2 Maintain electrical safety procedures and take necessary precautions to ensure safety of all personnel working under this Contract, as well as safety of other personnel on site.

17. ELECTRICAL LOCKOUT

.1 Develop, implement and enforce use of established procedures to provide electrical lockout and to ensure the health and safety of workers for every event where work must be done on any electrical circuit or facility.

.2 Prepare the lockout procedures in writing, listing step-by-step processes to be followed by workers, including how to prepare and issue the request / authorization form. Have procedures available for review upon request by the Departmental Representative.

.3 Keep the documents and lockout tags at the site and list in a log book for the full duration of the Contract. Upon request, make such data available for viewing by Departmental Representative or by any authorized safety representative.

18. OVERLOADING

.1 Ensure no part of work is subjected to a load which will endanger its safety or will cause permanent deformation.

19. FALSEWORK

.1 Design and construct falsework in accordance with CSA S269.1-1975 (R2003).

20. SCAFFOLDING

.1 Design, construct and maintain scaffolding in a rigid, secure and safe manner, in accordance with CSA Z797-2009 and B.C. Occupational Health and Safety Regulations.

21. CONFINED SPACES

.1 Carry out work in confined spaces in compliance with provincial regulations.

22. POWDER-ACTUATED DEVICES

.1 Use powder-actuated devices in accordance with ANSI A10.3 only after receipt of written permission from the Departmental Representative.

23. FIRE SAFETY AND HOT WORK

.1 Obtain Departmental Representative's authorization before any welding, cutting or any other hot work operations can be carried out on site.

.2 Hot work includes cutting/melting with use of torch, flame heating roofing kettles, or other open flame devices and grinding with equipment which produces sparks.

24. FIRE SAFETY REQUIREMENTS

.1 Store oily/paint-soaked rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

.2 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada 2015.

25. FIRE PROTECTION AND ALARM SYSTEM

.1 Fire protection and alarm systems shall not be:

.1 Obstructed.

.2 Shut off.

.3 Left inactive at the end of a working day or shift.

.2 Do not use fire hydrants, standpipes and hose systems for purposes other than firefighting.

.3 Be responsible/liable for costs incurred from the fire department, the Departmental Representative, and the tenants, resulting from false alarms.

26. UNFORESEEN HAZARDS

.1 Should any unforeseen or peculiar safety-related factor, hazard or condition become evident during performance of the work, immediately stop work and advise the Departmental Representative verbally and in writing.

27. POSTED DOCUMENTS

.1 Post legible versions of the following documents on site:

.1 Health and Safety Plan.

.2 Sequence of work.

.3 Emergency procedures.

.4 Site drawing showing project layout, locations of the first-aid station, evacuation route and marshalling station, and the emergency transportation provisions.

.5 Notice of Project.

.6 Floor plans or site plans.

.7 Notice as to where a copy of the Workers' Compensation Act and Regulations are available on the work site for review by employees and workers.

.8 Workplace Hazardous Materials Information System (WHMIS) documents.

.9 Material Safety Data Sheets (MSDS).

.10 List of names of Joint Health and Safety Committee members, or Health and Safety Representative, as applicable.

.2 Post all Material Safety Data Sheets (MSDS) on site, in a common area, visible to all workers and in locations accessible to tenants when work of this Contract includes construction activities adjacent to occupied areas.

.3 Postings should be protected from the weather, and visible from the street or the exterior of the principal construction site shelter provided for workers and equipment, or as approved by the Departmental Representative.

28. MEETINGS

.1 Attend health and safety pre-construction meeting and all subsequent meetings called by the Departmental Representative.

29. CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by the Departmental Representative.

.2 Provide Departmental Representative with written report of action taken to correct non-compliance with health and safety issues identified.

.3 The Departmental Representative may issue a "stop work order" if non-compliance of health and safety regulations is not corrected immediately or within posted time. The General Contractor/subcontractors will be responsible for any costs arising from such a "stop work order".

END OF SECTION

1.1 ACCESS AND DELIVERY

.1 Only the designated entrance may be used for access to building.

.1 Maintain for duration of Contract.

.2 Make good damage resulting from Contractor's use.

.2 All contractors are required to use only the loading dock entrance.

.3 Use of the ITF and CTF facility will be granted to the Contractor through the Departmental Representative.

.1 The shipping & receiving area is to be used for loading and unloading purposes only.

.2 Parking is not permitted. Security has been instructed to have unauthorized vehicles towed at the Contractor's expense.

1.2 STORAGE FACILITIES

.1 Storage space will be limited to the area of construction.

1.3 POWER

.1 Electrical power and lighting at existing building may be used for construction purposes at no extra cost, provided that warranties are not affected thereby and electrical components used for temporary power are replaced when damaged. Do not use emergency power or UPS panels for this purpose.

1.4 WATER SUPPLY

.1 Water supply is available at existing building and may be used for construction purposes at no cost.

1.5 SANITARY FACILITIES

.1 Existing designated washroom facilities may be used on approval of Departmental Representative. Clean and stock washroom daily and before final completion.

1.6 HEATING AND VENTILATION

.1 Do not begin work until arrangements have been made with the Departmental Representative for protection of on-floor heating, ventilating and air conditioning.

.1 If there is any dirt in the heating and ventilation system, it will be the Contractor's responsibility to return it to its original state in accordance with the Departmental Representative's specifications.

.2 Prevent dust and odour migration to other occupied areas.

.1 Do not activate HVAC system to occupied floors. Purge air from construction floors only when directed by Departmental Representative, where dust and fumes will be generated.

.2 Change filters in existing HVAC system frequently.

1.7 SCAFFOLDING

.1 Construct and maintain scaffolding in rigid, secure and safe manner.

.2 Erect scaffolding independent of walls. Remove promptly when no longer required.

1.8 REMOVAL OF TEMPORARY FACILITIES

.1 Remove temporary facilities from site when directed by the Departmental Representative.

1.9 SIGNS AND NOTICES

.1 Signs and notices for safety and instruction shall be in both official languages or graphic symbols conforming to CAN/CSA-Z321.

.2 Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or when directed by Departmental Representative.

END OF SECTION

1.1 PRODUCTS/MATERIAL AND EQUIPMENT

.1 Use NEW products/material and equipment unless otherwise specified. The term "products" is referred to throughout the specifications.

.2 Use products of 1 manufacturer for material and equipment of the same type or classification unless otherwise specified.

.3 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.

.4 Notify Departmental Representative in writing of any conflict between these specifications and manufacturer's instructions. Departmental Representative will designate which document is to be followed.

.5 Provide metal fastenings and accessories in the same texture, colour and finish as base metal in which they occur.

.1 Prevent electrolytic action between dissimilar metals.

.2 Use non-corrosive fasteners, anchors and spacers for securing exterior work.

.6 Fastenings which cause spalling or cracking are not acceptable.

.7 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

.8 Use heavy hexagon heads, semi-finished unless otherwise specified.

.9 Bolts may not project more than 1 diameter beyond nuts.

.10 Types of washers as follows:

.1 Plain type washers: use on equipment and sheet metal.

.2 Soft gasket lock type washers: use where vibrations occur.

.3 Resilient washers: use with stainless steel.

.11 Deliver, store and maintain packaged material and equipment with manufacturer's seals and labels intact.

.12 Prevent damage, adulteration and soiling of products during delivery, handling and storage. Immediately remove rejected products from site.

.13 Store products in accordance with suppliers' instructions.

.14 Touch up damaged factory finished surfaces to Departmental Representative's satisfaction:

.1 Use primer or enamel to match original.

.2 Do not paint over nameplates.

1.2 QUALITY OF PRODUCTS

.1 Products, materials and equipment (referred to as products) incorporated into work shall be new, not damaged or defective, and of the best quality (compatible with the specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of the products provided.

.2 Defective products will be rejected regardless of previous inspections.

.1 Inspection does not relieve responsibility, but is precaution against oversight or error.

.2 Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.

.3 Retain purchase orders, invoices and other documents to prove that all products utilized in this Contract meet the requirements of the specifications. Produce documents when requested by the Departmental Representative.

.4 Should any dispute arise as to quality or fitness of products, the decision rests strictly with the Departmental Representative based upon the requirements of the Contract documents.

.5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the 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.

1.3 AVAILABILITY OF PRODUCTS

.1 Immediately upon signing the Contract, review product delivery requirements and anticipate foreseeable supply delays for any items.

.2 If delays in supply of products are foreseeable, notify Departmental Representative of such in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of the work.

.3 In event of failure to notify Departmental Representative at the start of work and should it subsequently appear that the work may be delayed for such reason, the Departmental Representative reserves the right to substitute more readily available products of similar character, at no increase in either the Contract price or the Contract time.

1.4 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in the specifications, install or erect products in accordance with the manufacturer's instructions.

.1 Do not rely on labels or enclosures provided with products.

.2 Obtain written instructions directly from the manufacturer.

.2 Notify Departmental Representative in writing of conflicts between the specifications and the manufacturer's instructions so that the Departmental Representative may establish the course of action.

.3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Departmental Representative to require removal and re-installation at no increase in either the Contract price of the Contract time.

1.5 CONTRACTOR'S OPTIONS FOR SELECTION OF PRODUCTS FOR TENDERING

.1 Products are specified by **"Prescriptive" specifications**: select any product meeting or exceeding specifications.

.2 Products specified under **"Acceptable Products"** (used for complex Mechanical or Electrical Systems): select any one of the indicated manufacturers, or any other manufacturer meeting or exceeding the Prescriptive specifications and indicated Products.

.3 Products specified by performance and referenced standard: select any product meeting or exceeding the referenced standard.

.4 Products specified to meet particular design requirements or to match existing materials: use only material specified Approved Product. Alternative products may be considered provided full technical data is received in writing by Departmental Representative in accordance with "Special Instructions to Tenderers".

.5 When products are specified by a referenced standard or by Performance specifications, upon request of Departmental Representative obtain from manufacturer and independent laboratory report showing that the product meets or exceeds the specified requirements.

1.6 SUBSTITUTION AFTER CONTRACT AWARD

.1 No substitutions are permitted without prior written approval of the Departmental Representative.

.2 **Proposals for substitution may only be submitted after Contract award**. Such request must include statements of respective costs of items originally specified and the proposed substitution.

.3 Proposals will be considered by the Departmental Representative if:

.1 products selected by tenderer from those specified are not available;

.2 delivery date of products selected from those specified would unduly delay completion of Contract, or

.3 alternative product to that specified, which is brought to the attention of considered by Departmental Representative as equivalent to the product specified, and will result in a credit to the Contract amount.

.4 **Should the proposed substitution be accepted either in part or in whole, assume full responsibility and costs when substitution affects other work on the project. Pay for design or drawing changes required as result of substitution**.

.5 Amounts of all credits arising from approval of the substitutions will be determined by the Departmental Representative, and the Contract price will be reduced accordingly.

END OF SECTION

1.1 RELATED WORK

.1 Refer to every technical section for waste management and disposal.

1.2 DEFINITIONS

.1 Waste Audit (WA): relates to projected waste generation. Involves controlled separation of waste.

.2 Waste Reduction Workplan (WRW): a written report which addresses opportunities for reduction, re-use or recycling of materials.

.3 Materials Source Separation Program (MSSP): consists of a series of ongoing activities to separate re-usable and recyclable waste material into material categories from other types of waste at point of generation.

1.3 MATERIALS SOURCE SEPARATION

.1 Before project start-up, prepare Materials Source Separation Program. Provide separate containers for re-usable and/or recyclable materials of the following:

.1 Gypsum board.

.2 Metals.

.3 Wood.

.4 Plastics

.5 Other materials as indicated in technical sections.

.2 Implement Materials Source Separation Program for waste generated on project in compliance with approved methods and as approved by Departmental Representative.

:3 Locate containers in locations, to facilitate deposit of materials without hindering daily operations.

.4 Locate separated materials in areas which minimize material damage.

1.4 DIVERSION OF MATERIALS

.1 Create a list of materials to be separated from the general waste stream and stockpiled in separate containers, to the approval of the Departmental Representative and consistent with applicable fire regulations.

.1 Mark containers.

.2 Provide instruction on disposal practices.

1.5 STORAGE, HANDLING AND APPLICATION

.1 Do work in compliance with Waste Reduction Workplan.

.2 Handle waste materials not re-used, salvaged, or recycled in accordance with appropriate regulations and codes.

.3 Materials in separated condition: collect, handle, store on site, and transport off-site to an approved and authorized recycling facility.

.4 Materials must be immediately separated into required categories for re-use or recycling.

.5 Unless specified otherwise, materials for removal become the Contractor's property.

.6 On-site sale of salvaged/recyclable material is not permitted.

.7 **Provide Departmental Representative with receipts** indicating quantity of material delivered to landfill.

.8 **Provide Departmental Representative with receipts** indicating quantity and type of materials sent for recycling.

END OF SECTION

1.1 SUBMISSION

.1 Prepare instructions and data by personnel experienced in maintenance and operation of described products.

.2 Revise content of documents as required before final submittal.

.3 Phasing of submission:

.1 Two weeks before substantial performance of the work for Phase 1 construction, submit to Departmental Representative 4 final copies of operation and maintenance manuals.

.2 Two weeks before substantial performance of the work for Phase 2 construction, submit to Departmental Representative 4 final copies of Phase 2 supplements to operation and maintenance manuals.

.4 Ensure spare parts, maintenance materials and special tools provided are new, neither damaged nor defective, and of same quality and manufacture as products provided in work.

.5 If requested, furnish evidence as to type, source and quality of products provided.

.6 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

.7 All material shall be supplied in hard and digital format.

1.2 FORMAT

.1 Organize data in the form of an instructional manual.

.2 Binders: vinyl, hard covered, 3 "D" ring, loose leaf 219x279 mm with spine and face pockets.

.3 Cover: identify each binder with typed or printed title "Project Record Documents"; list title of project and identify subject matter of contents.

.4 Arrange content by systems under section numbers and sequence of Table of Contents.

.5 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.6 Text: manufacturer's printed data, or typewritten data.

.7 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.3 CONTENTS, EACH VOLUME

.1 Table of contents – provide the following:

.1 Title of project.
Date of submission.

.2 Names, addresses, and telephone numbers of Departmental Representative and Contractor with name of responsible parties.

.3 Schedule of products and systems, indexed to content of volume.

.2 For each product or system, list names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product data: mark each sheet to clearly identify products and component parts, and data applicable to installation. Delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

1.4 AS-BUILT DOCUMENTS

.1 **Contract drawings** and shop drawings: legibly mark each item to record actual construction, including:

- .1 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
- .2 Field changes of dimension and detail.
- .3 Changes made by change orders.
- .4 Details not on original Contract drawings.
- .5 References to related shop drawings and modifications.

.2 **Contract Specifications**: legibly mark each item to record actual "Workmanship of Construction", including;

- .1 Manufacturer, trade name, and catalogue number of each "Product/Material" actually installed, particularly optional items and substitute items.
- .2 Changes made by addenda and change orders.

.3 As-built information:

- .1 Record changes in red ink.
- .2 Mark on 1 set of drawings, specifications and shop drawings at completion of project and, before final inspection, neatly transfer notations to second set.
- .3 Provide 1 set of CDs in AutoCAD dwg. file format with all as-built information on the CDs.
- .4 Submit all sets for the Departmental Representative.

1.5 EQUIPMENT AND SYSTEMS

.1 Operating procedures – include the following:

- .1 Start-up, break-in, and routine normal operating instructions and sequences.
- .2 Regulation, control, stopping, shutdown, and emergency instructions.
- .3 Summer, winter, and any special operating instructions.

.2 Maintenance requirements – list routine procedures:

- .1 Filter change
- .2 Lubrication
- .3 Belt change
- .4 Chemical testing

.3 Provide servicing and lubrication schedule, and list of lubricants required.

.4 Include manufacturer's printed operation and maintenance instructions.

.5 Include sequence of operation by controls manufacturer.

.6 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.7 Provide installed control diagrams by controls manufacturer.

.8 Provide Contractor's coordination drawings with installed colour coded piping diagrams.

.9 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.10 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.11 Additional requirements: as specified in individual specification Sections.

1.6 MANUFACTURER'S DOCUMENTATION REPORTS

.1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and system, instruct Departmental Representative's indicated facility's personnel, and provide detailed written report that demonstration and instructions have been completed.

.2 Departmental Representative will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

1.7 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 on-site location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to the Departmental Representative. Include approved listings in maintenance manual.

.5 Obtain receipt for delivered products and submit to Departmental Representative.

1.8 MAINTENANCE 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 on-site location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to the Departmental Representative. Include approved listings in maintenance manual.

.5 Obtain receipt for delivered products and submit to Departmental Representative.

1.9 WARRANTIES, BONDS, TEST REPORTS, INSPECTION REPORTS

.1 Separate each Document 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, Bonds, Test Results, Inspection Reports executed in duplicate by subcontractors, suppliers, manufacturers, and inspection agencies within 10 days after completion of the applicable item of work.

.4 Except for items put into use with the Departmental Representative's permission, leave date of beginning of time of warranty until the date of substantial performance is determined.

.5 Verify that documents are in proper form, contain full information, and are notarized.

.6 Co-execute submittals when required.

.7 Retain warranties and bonds until time specified for submittal.

1.10 COMPLETION

.1 Submit a written certificate that the following have been performed:

.1 Work has been completed and inspected for compliance with the Contract documents.

.2 Defects have been corrected and deficiencies have been completed.

.3 Equipment and systems have been tested, adjusted and balanced, and are fully operational.

.4 Certificates required by the Boiler Inspection Branch, Fire Commissioner of Canada, and utility companies have been submitted.

.5 Operation of systems has been demonstrated to the personnel indicated by the Departmental Representative.

.6 Work is complete and ready for final inspection.

END OF SECTION

1.1 SECTION INCLUDES

.1 Includes general requirements for commissioning facilities and facility systems.

.2 Refer to sections of Mechanical and Electrical disciplines.

.3 Refer to Cx – Commissioning Plan in Appendix 1.

1.2 DEFINITIONS

.1 Acronyms:

.1 AFD – Alternate Forms of Delivery, service provider.

.2 BMM – Building Management Manual.

.3 Cx – Commissioning.

.4 EMCS – Energy Monitoring and Control Systems.

.5 O&M – Operation and Maintenance.

.6 PI – Product Information.

.7 PV – Performance Verification.

.8 TAB – Testing, Adjusting and Balancing.

.2 Cx – a required program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed by an independent Cx Agent in accordance with CSA Z320-11 Building Commissioning after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.

1.3 QUALITY ASSURANCE

.1 The General Contractor shall engage the services of an independent commissioning agent.

.2 Testing organization: an current member in good standing of AABC certified to perform specified services.

.3 Comply with applicable procedures and standards of the certification sponsoring association.

.4 Perform services under direction of supervisor qualified under certification requirements of sponsoring association.

.5 Commissioning shall be executed in accordance with CSA Z320-11 Building Commissioning.

1.4 REFERENCES

.1 Associated Air Balance Council (AABC): National Standards for Field Measurement and Instrumentation, Total Systems Balance, Air Distribution-Hydronics Systems.

1.5 SUBMITTALS

.1 Prior to start of Work, submit name of organization proposed to perform services. Designate who has managerial responsibilities for coordination of entire testing, adjusting and balancing.

.2 Submit documentation to confirm organization compliance with quality assurance provision.

.3 Submit 3 preliminary specimen copies of each of report forms proposed for use.

.4 Ten (10) days prior to Substantial Performance, submit 3 copies of final reports on applicable forms.

.5 Submit reports of testing, adjusting and balancing postponed due to seasonal, climatic, occupancy, or other reasons beyond Contractor's control, promptly after execution of those services.

1.6 PROCEDURES – GENERAL

.1 Comply with procedural standards of certifying association under whose standard services will be performed.

.2 Notify Departmental Representative 3 days prior to beginning of operations.

.3 Accurately record data for each step.

.4 Report to Departmental Representative any deficiencies or defects noted during performance of services.

1.7 CONTRACTOR'S RESPONSIBILITIES

.1 Prepare each system for testing and balancing.

.2 Cooperate with testing organization and provide access to equipment and systems.

.3 Provide personnel and operate systems at designated times, and under conditions required for proper testing, adjusting, and balancing.

.4 Notify testing organization 7 days prior to time project will be ready for testing, adjusting, and balancing.

1.8 PREPARATION

.1 Provide instruments required for testing, adjusting, and balancing operations.

.2 Make instruments available to Departmental Representative to facilitate spot checks during testing.

.3 Retain possession of instruments and remove at completion of services.

.4 Verify systems installation is complete and in continuous operation.

.5 Verify lighting is turned on when lighting is included in cooling load.

.6 Verify equipment such as computers, laboratory and electronic equipment are in full operation.

1.9 FINAL REPORTS

.1 Organization having managerial responsibility shall make reports.

.2 Ensure each form bears signature of recorder, and that of supervisor of reporting organization.

.3 Identify each instrument used, and latest date of calibration of each.

1.10 COMPLETION OF COMMISSIONING

.1 Upon completion of Cx leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.

.3 Cx deliverables have been submitted and accepted by Departmental Representative.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 The General Conditions, Supplements and Amendments shall govern this Division (read in conjunction with Instructions to Tenderers / Bidders). ***This section covers items common to all sections of Division 23 and is intended only to supplement the requirements of Division 1.***

.2 The word "Provide" shall mean "Supply and Install" the products and services specified. "As Indicated" means that the item(s) specified are shown on the drawings.

.3 Provide materials, equipment and plant, of specified design, performance and quality; and, current models with published certified ratings for which replacement parts are readily available. Provide project management and on-site supervision to undertake administration, meet schedules, ensure timely performance, ensure coordination, establish orderly completion and the delivery of a fully commissioned installation.

.4 The most stringent requirements of this and other mechanical sections shall govern.

.5 All work shall be in accordance with the PROJECT Drawings and Specifications and their intent, complete with all necessary components, including those not normally shown or specified, but required for a complete installation.

1.2 STANDARD OF ACCEPTANCE

.1 Means that item named and specified by manufacturer and/or catalogue number forms part of specification and sets standard regarding performance, quality of material and workmanship and when used in conjunction with a referenced standard, shall be deemed to supplement the standard.

.2 Acceptable Product manufacturers are listed in the HVAC – Equipment manufacturers in Section 23 06 03.

.3 Where two or more manufacturers are listed, the manufacturer's name shown underlined or shown with a model name and/or number was used in preparing the design. Tenders may be based on any one of those named, provided that they meet every aspect of the drawings and specifications.

.4 Where other than the <u>underlined</u> manufacturer or scheduled/specified manufacturer is selected or approved, include for the cost of any resulting work (both under this Division and other Divisions) and any necessary redesign of installation or structure. Submit redesign drawings for review with Shop Drawings. Maintain installation, access and servicing clearances. Redesign drawings shall be to scale and of a standard equal to the Project Drawings.

.5 Where two or more items of equipment and/or material, of the same type, are required, provide products of a single manufacturer.

.6 Install and test all equipment and material, in accordance with the detailed recommendations of the manufacturer.

.7 A visible manufacturer's nameplate shall indicate manufacturer's name, model number, serial number, capacity data, electrical characteristics and approval stamps.

1.3 ADDITION OF ACCEPTABLE MANUFACTURERS

.1 Material/products considered to satisfy the specification, but of a manufacturer other than those named in the Equipment Supplier Schedule may be submitted to the Departmental Representative for consideration not later than five (5) working days prior to closing of tender or of bid depository subtrade tender whichever is earlier.

.2 Addition of manufacturer's names to the specifications will be by addendum only.

1.4 DETAILED PRICE BREAKDOWNS

.1 10 days after the award of contract submit price breakdowns on photocopies of the Price Breakdown Forms included in Section 23 06 02. Submit a separate breakdown for each section of the mechanical work listed on the Progress Claim Summary Form in Section 23 06 02.

.2 In particular cases more detail may be necessary to properly assess a change order or progress claim. This additional information, which could include all suppliers and all sub-contractors, shall be supplied when requested by the Departmental Representative.

.3 Mark-up information is required for change orders but is optional on the original tender price.

1.5 PROGRESS CLAIMS

.1 Submit with each progress claim a progress claim summary based on the Progress Claim Summary Form included in Section 23 06 02.

.2 Submit detailed price breakdowns on a photocopy of the Detailed Price Breakdown Form for each section of the mechanical work listed on the Progress Claim Summary Form and for each separate mechanical change order item exceeding $20,000.00.

.3 Progress claims will not be certified nor payment made beyond 90% on the overall Mechanical (H.V.A.C.) contract and beyond 70% on the Control systems contract, until commissioning and verification of the systems are complete. (The 70% limit on Controls is included in the overall fig.). This procedure is to allow for any necessary deficiency holdbacks on items which do not become apparent until the systems are commissioned.

1.6 SCHEDULING

.1 Incorporate within the Construction Schedule, a complete and realistic schedule, integrated with, and recognizing the reliance on, other divisions of the work. Take into account the lead time for the review of operating and maintenance manuals, commissioning, verification of system operation by the Departmental Representative and the demonstration and instruction to the Owner. The schedule shall include but not limited to the following items:

.1 Installation and testing of piping systems and equipment.

.2 Chemical cleaning and treatment of piping.

.3 Control system installation.

.4 Water balancing

.5 Connection of electrical services to equipment by electrical contractor.

.6 Start-up of mechanical equipment and systems.

.7 Check-out of control systems.

.8 Commissioning of mechanical systems.

.9 Demonstration of systems and equipment to Departmental Representative.

.10 Demonstration of systems and equipment to Owner.

.11 Preparation of maintenance manuals and as-built drawings.

.12 Submission of the various documents required prior to substantial performance.

1.7 RESPONSIBILITIES

.1 Visit the site before tendering. Examine all local and existing conditions on which the work is dependent.

.2 No consideration will be granted for any misunderstanding, of work to be done, resulting from failure to visit the site.

.3 Ensure that equipment does not transmit noise and/or vibration to other parts of the building, as a result of poor installation practice.

.4 Where the Contract Documents do not contain sufficient information for the proper selection of equipment for bidding, notify the Departmental Representative during the tendering period. If clarification is not obtainable, allow for the most expensive arrangement. Failure to do this shall not relieve the Contractor of responsibility to provide the intended equipment.

1.8 COORDINATION

.1 Check drawings of all trades to verify space and headroom limitations for work to be installed. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent involving extra cost to the Owner, without the Departmental Representative's written approval.

.2 The drawings indicate the general location and route to be followed by the piping and boiler vents. Where details are not shown on the drawings or only shown diagrammatically, the pipes and boiler vents shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines. All pipes in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All pipes and boiler vents shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.

.3 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. Where necessary produce interference drawings showing exact locations of mechanical equipment within service areas, shafts and the ceiling space. Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Departmental Representative of space problems before fabricating, or installing any material or equipment. Demonstrate to the Departmental Representative on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required.

1.9 PERMITS

.1 Obtain all required permits and pay all fees therefore and comply with all Provincial, Municipal and other legal regulations and bylaws applicable to the work.

.2 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work, furnish final unconditional certificates of approval by the inspecting authorities.

1.10 CODES, REGULATIONS AND STANDARDS

.1 Division 23 work shall conform to the following codes, regulations and standards, and all other codes in effect at the time of award of Contract, and any others having jurisdiction. The latest revision of each code and standard shall apply unless otherwise specified in the contract documents:

.1 Bylaws

.1 Local Building Bylaws.

.2 Canadian Gas Association

.1 National Standard of Canada CAN/CGA-B149.1-10 - Natural Gas Installation Code.

.3 Canadian Standards Association

.1 CSA Standard C22.1, Canadian Electrical Code.

.2 CSA Standard B51-14, Boiler, Pressure Vessel and Pressure Piping Code.

.3 National Research Council of Canada

.1 NRCC 23174 National Building Code of Canada 2015.

.2 NRCC 23178 National Building Code of Canada, Supplement 2012.

.3 NRCC 23175 National Fire Code of Canada 2015.

.4 Province of British Columbia

.1 B.C. Safety Authority Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation - 2004.

.2 B.C. Amendment to Canadian Electrical Code.

.3 B.C. Electrical Safety Branch Bulletins - 2004.

.4 B.C. Code Amendments, Gas Safety Act & Regulations.

.5 B.C. Industrial Health & Safety Regulations, Workers' Compensation Board of British Columbia.

.6 B.C. Reg 103/2004 Gas Safety Regulation.

.6 SMACNA Publications

.1 H.V.A.C. Duct Construction Standards, 2006.

.2 Guidelines for seismic restraints of mechanical systems.

.2 Where these specifications specifically indicate requirements more onerous than the aforementioned codes, these specifically indicated requirements shall be incorporated into the work.

1.11 WARRANTY

.1 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the General Conditions.

.2 Take note of any extended warranties specified.

.3 Refer to Section 23 09 01 for Control System warranty requirements.

1.12 ENERGY CONSUMPTION

.1 Departmental Representative may reject equipment submitted for approval or review on basis of performance or energy consumed or demanded.

1.13 ASBESTOS

.1 All material / products installed shall be free of asbestos.

1.14 WORKMANSHIP

.1 Workmanship shall be in accordance with well-established practice and standards accepted and recognized by the Departmental Representative and the Trade.

.2 The Departmental Representative shall have the right to reject any item of work that does not conform to the Contract Documents and accepted standards of performance, quietness of operation, finish and appearance.

.3 Employ only tradesmen holding valid Provincial Trade Qualification Certificates. Tradesmen shall perform only work that their certificate permits. Certificates shall be available for inspection by the Departmental Representative.

1.15 DRAWINGS AND MEASUREMENTS

.1 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work and are not detailed installation drawings. Do not scale the drawings. Obtain accurate dimensions from the Architectural and Structural drawings.

.2 Consult the architectural drawings and details for exact locations of fixtures and equipment. Obtain this information from the Departmental Representative where definite locations are not indicated.

.3 Take field measurements, where equipment and material dimensions are dependent upon building dimensions.

.4 Where imperial units have been indicated in brackets [ ] following the requirements in SI units, the conversion is approximate and provided for convenience. The SI units shall govern.

1.16 CONCEALMENT

.1 Conceal all piping, ductwork and conduit in partitions, walls, crawlspaces and ceiling spaces, unless otherwise noted.

.2 Do not install piping and conduit in outside walls or roof slabs unless specifically directed, in which case, install them with the building insulation between them and the outside face of the building.

1.17 ACCESSIBILITY

.1 Install all work so as to be readily accessible for adjustment, operation and maintenance. Furnish access doors where required in building surfaces for installation by building trades. Refer to item "Access Doors".

1.18 PIPING EXPANSION

.1 Install piping with all necessary changes of direction, expansion loops, anchors and guides so that expansion and contraction will not overstress the piping and equipment piping connections.

.2 Expansion loops shall be of all welded construction with long radius elbows; cold sprung 50% and located between anchors.

.3 Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.

1.19 PROTECTION OF WORK

.1 Protect equipment and materials, stored or in place, from the weather, moisture, dust and physical damage.

.2 Mask machined surfaces. Secure covers over equipment openings and open ends of piping, ductwork and conduits, as installation work progresses.

.3 Equipment having operating parts, bearings or machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.

.4 Refinish damaged or marred factory finish.

.5 Air systems to have air filters installed before fans are operated. Install new air filters before system acceptance.

1.20 SEQUENCE OF WORK

.1 Before interrupting major services notify the Departmental Representative well in advance and arrange an acceptable schedule for the interruptions.

.2 Before interrupting any services complete all preparatory work as far as reasonably possible and have all necessary materials on site and prefabricated (where practical) and work continuously to keep the length of interruption to a minimum.

.3 Include for the cost of all work that may be required out of regular hours to minimize the period of service interruption when connecting into the existing systems.

1.21 BUILDING OPERATION DURING CONSTRUCTION

.1 In order to minimize operational difficulties for the building staff, the various trades must cooperate with the owner throughout the entire construction period and particularly ensure that noise is minimized.

.2 Convenient access for the staff and public to the building must be maintained at all times. Minor inconvenience and interruption of services will be tolerated, provided advance notice is given, but the Contractor will be expected to coordinate his work, in consultation with the owner, so the operation of the facility can be maintained as nearly normal as possible.

1.22 SHOP DRAWINGS/PRODUCT DATA

.1 Process

.1 Shop drawings/product data shall be submitted as listed in Section 23 06 03, H.V.A.C. Equipment Suppliers Schedule.

.2 Shop drawings/product data shall be reviewed, signed and processed as described in the General Conditions, in Division 1.

.2 Content

.1 Shop drawings submitted title sheet.

.2 Data shall be specific and technical.

.3 Identify each piece of equipment.

.4 Information shall include all scheduled data.

.5 Advertising literature will be rejected.

.6 The project shall be identified on each document.

.7 Information shall be given in S.I. units.

.8 The shop drawings/product data shall include:

.1 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with all equipment weights and mounting point loads.

.2 Mounting arrangements.

.3 Capacity and performance characteristics indicated on performance curves for fans and pumps.

.4 Sound Power Data, where requested.

.5 Motor efficiencies on motors 1H.P. and larger.

.6 List of the manufacturers and figure numbers for all valves, traps and strainers.

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

.8 Control explanation and internal wiring diagrams for packaged equipment.

.9 Electrical control system drawings.

.10 Interlock wiring and control schematic diagrams including details of all component parts in order that the function of each is displayed.

.11 A written description of control sequences relating to the schematic diagrams.

.3 Format

.1 Black line prints 216 mm x 280 mm [8-1/2" x 11"] or 280 mm x 430 mm [11" x 17"].

.2 Larger drawings may be submitted on reproducible sepia with space for stamps and signatures - master set plus one working copy.

.3 An assembly of related components, e.g. grilles, registers and diffusers or radiation with sheet metal cabinets, etc. between covers with the contents, identified by model number, listed on the front cover with item identification numbers.

.4 A brochure for plumbing fixtures between covers with the contents named with model numbers listed on the front cover with item identification numbers.

.4 Coordination

.1 Where mechanical equipment requires electrical connections, power or other services, the shop drawings shall also be circulated through the Electrical Contractor (or other "services" contractor(s)) prior to submission to the Departmental Representatives.

.2 Submit shop drawings and product data.

.5 Keep one [1] copy of shop drawings and product data, on site, available for reference.

1.23 EQUIPMENT INVENTORY SHEETS

.1 Equipment Inventory Sheets are attached at the end of this section. See sample sheet. Fill out inventory sheets and submit together with shop drawings.

1.24 EQUIPMENT RESTRAINT

.1 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

1.25 EQUIPMENT INSTALLATION

.1 Provide unions and flanges to permit equipment maintenance and disassembly and to minimize disturbance to piping and duct systems and without interfering with building structure or other equipment.

.2 Provide means of access for servicing equipment including permanently lubricated bearings.

.3 Pipe equipment drains to floor drains.

.4 Line up equipment, rectangular cleanouts and similar items with building walls wherever possible.

1.26 ANCHOR BOLTS AND TEMPLATES

.1 Supply anchor bolts and templates for installation by other divisions.

1.27 ACCESS DOORS (APPLIES ONLY FOR NOT SECURED AREAS)

.1 Supply flush mounted access doors, for installation by Building Trades in furred ceilings and walls, to permit servicing of mechanical equipment and accessories, inspection of life safety or operating devices, <u>and where specifically indicated.</u>

.2 Unless otherwise noted, access doors shall be minimum: 450mmx450mm [18"x18"] for body entry; 300mmx300mm [12"x12"] for hand entry; 200mmx200mm [8"x8"] for cleanout access. Access doors in building surfaces shall be at least as large as duct access panels accessed through them and shall be oversized when necessary.

.3 Locate access doors so that all concealed items are readily accessible for adjustment, operation and maintenance. Locate in service and storage areas wherever possible. Do not locate in panelled, feature or special finish walls, without prior approval of the Departmental Representative.

.1 Access doors in fire separations of 3/4 hour rating, and higher, and firewalls shall have a compatible fire rating and a ULC label with tamper-proof latch, self- closing.

.4 Minimum Requirements:

.1 180 degree door swing, mitred rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, all steel prime coated.

.2 Plaster or wet wall construction: 14 gauge bonderized steel flush with wall or ceiling type with concealed flange.

.1 Acceptable Product: Acudor PS-5030.

.3 Masonry or drywall construction: 16 gauge for 400 mm [16"] x 400 mm [16"] and smaller, 14 gauge for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange.

.1 Acceptable Product: Acudor UF-5000.

.4 Tile, ceramic tile, marble, terrazzo, plaster or wet wall construction in washrooms and other special areas: 14 gauge stainless steel flush with wall or ceiling type with concealed flange.

.1 Acceptable Product: Acudor PS-5030 stainless.

.5 Acoustical tile ceiling and similar block materials: 14 gauge bonderized steel recessed ceiling type.

.1 Acceptable Product: Acudor AP-5010 or AT-5020.

.6 Feature wall construction: Recessed wall type that is selected to complement and conform with the architectural module, treatment, or panelling. The size shall conform to adjacent finishes.

.7 Access panels in fire separations and fire walls shall have a compatible fire rating and ULC label. (ie. Acudor Fire Rated FW-5050 or FB-5060).

.5 Standard of Acceptance: Zurn, Wade, Acudor, Can-Aqua, Milcor, Maxam, Van-Met.

1.28 CUTTING, PATCHING, DIGGING, CANNING AND CORING

.1 Lay out all cutting, patching, digging, canning and coring required to accommodate the mechanical services. Coordinate with other Divisions. The performance of actual cutting, patching, digging, canning and coring is specified under other Divisions. Be responsible for correct location and sizing of all openings required under Division 23 including pipe sleeves and duct openings. Allow oversized openings for fire dampers and pipe penetrations where insulation is specified.

.2 Be responsible for all cutting, patching, digging, canning and coring required to accommodate the mechanical services.

.3 Openings through structural members of the building shall not be made without the approval of the Departmental Representative.

1.29 FASTENING TO BUILDING STRUCTURE

.1 General:

.1 Do not use inserts in base material with a compressive strength less than 13.79 MPa [2000 psi] [refer to structural drawings].

.2 All inserts supporting piping shall have a factor of safety of 5. All other inserts shall have a factor of safety of 4.

.2 Types:

.1 Cast-in-place type:

.1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.

.2 Wedge type galvanized steel concrete insert, Grinnell Fig. 281 for up to 200 mm [8"] pipe size.

.3 Universal type malleable iron body insert, Grinnell Fig. 282 for up to 200 mm [8"] pipe size.

.4 Screw concrete insert, Grinnell Fig. 152 for up to 300 mm [12"] pipe size.

.2 Drilled, mechanical expansion type:

.1 Hilti HSL or UCAN LHL heavy duty anchor for use in concrete with compressive strength not less than 19.6 MPa [2840 psi].

.2 Hilti Kwik-Bolt or UCAN WED stud anchor for concrete. (Do not use in seismic restraint applications).

.3 Hilti HDI or UCAN IPA drop-in anchor for concrete.

.4 Hilti or UCAN Sleeve Anchor (medium and light duty) for concrete and masonry.

.5 Hilti ZBP or UCAN Zamac pin bolt (light duty) for concrete and masonry.

.3 Drilled, adhesive type:

.1 Hilti HVA or UCAN Adhesive Anchor consisting of anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.

.2 Hilti HY150 consisting of anchor rod with a 2 part adhesive system.

.3 For use in concrete housekeeping bases (in vertical downward position) where the distance to the edge of the concrete base could cause weakness if a mechanical expansion type anchor were used.

.4 Rod assemblies shall extend a minimum of 50 mm [2"] into the concrete slab below the housekeeping bases.

.3 Note:

.1 All drilling for inserts shall be performed using the appropriate tool specifically designed for the particular insert. The diameter and depth of each drilled hole shall be to the exact dimensions as specified by the insert manufacturer.

.2 Refer to manufacturer's recommendations for tightening torques to be applied to inserts.

.3 Where specifically called for, drills shall include a dust vacuum system, Hilti SAV Dust Vacuum System.

1.30 MISCELLANEOUS METAL

.1 Be responsible for all miscellaneous steel work relative to Division 23 of the Specifications, including but not limited to:

.1 Support of equipment.

.2 Hanging, support, anchoring, guiding and relative work as it applies to piping, venting, boilers, expansion tanks, pumps and mechanical equipment.

.3 Earthquake restraint devices - refer to Section 23 05 49.

.4 Access platforms, ladders and catwalks.

.5 Pipe anchor and/or support posts.

.6 Ceiling ring bolts - secure to structure or steel supports.

1.31 SERVICE PENETRATIONS IN RATED FIRE SEPARATIONS

.1 All piping, tubing, ducts, wiring, conduits, etc. passing through rated fire separations shall be smoke and fire proofed with ULC approved materials in accordance with CAN4-S115-M95 standard and which meet the requirements of the Building code in effect. This includes new services which pass through existing rated separations and also all existing services which pass through a new rated separation or existing separations whose rating has been upgraded.

.2 Fire resistance rating of installed firestopping assembly shall not be less than fire resistance rating of surrounding assembly indicated on Architectural drawings.

.3 All smoke and fire stopping shall be installed by a qualified Contractor who shall submit a letter certifying that all work is complete and in accordance with this specification. Mechanical Form MF173 in Section 23 06 02 should be used for this purpose.

.4 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions in formed, sleeved or cored penetrations.

.5 At all fire dampers use ULC approved fire stop sealant to caulk all joints (Check with fire damper manufacturer to ensure that the application of fire stop sealant will not void the UL listing of the damper):

.1 Between fire damper sleeve angles and the sleeves and

.2 Between fire damper sleeve angles and the fire separation.

1.32 SERVICE PENETRATIONS IN NON-RATED SEPARATIONS

.1 All piping, tubing, ducts, wiring, conduits, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent the passage of smoke and/or transmission of sound. Refer to "pipe sleeve" clause in this section for packing and sealing of pipe sleeves.

1.33 PIPE SLEEVES

.1 Provide pipe sleeves for all piping passing through rated walls and floors. Sleeves to be concentric with pipe.

.2 Pipes and ducts passing through fire rated separations that have no fire resistance (non-rated separations) do not require a sleeve, but the insulation at the separation should be wrapped with 0.61 [24 ga] thick galvanized sheet steel band to which to apply the flexible caulking compound to.

.3 Pipe sleeves for floors and interior walls shall be minimum 0.61 [24 ga] thick galvanized sheet steel with lock seam joints.

.4 Pipe sleeves for perimeter walls and foundation walls shall be cast iron sleeve or Schedule 40 steel pipe with annular fin continuously welded at midpoint. Annular fin shall be embedded into centre of wall.

.5 Pipe sleeves for wet or washdown floor areas such as washrooms, janitors' rooms, laboratories and mechanical equipment rooms shall be Schedule 40 steel pipe.

.6 Except as otherwise noted pipe sleeves are not required for holes formed or cored in interior concrete walls or floors.

.7 Pipe sleeves shall extend 50 mm [2"] above floors in unfinished areas and wet areas and 6 mm [1/4"] above floors in finished areas.

.8 Pipe sleeves shall extend 25 mm [1"] on each side of walls in unfinished areas and 6 mm [1/4"] in finished areas.

.9 Pipe sleeves shall extend 25mm [1"] beyond exterior face of building. Caulk with flexible caulking compound.

.10 Sleeve Size: 12 mm [1/2"] clearance all around, between sleeve and pipe or between sleeve and pipe insulation.

.11 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.

.12 Packing of Sleeves:

.1 Where sleeves pass through foundation walls and perimeter walls the space between sleeve and pipe or between sleeve and pipe insulation shall be caulked with waterproof fire retardant non-hardening mastic.

.2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

1.34 ESCUTCHEONS AND PLATES

.1 Provide on pipes passing through finished walls, partitions, floors and ceilings.

.2 Plates shall be stamped steel, split type, chrome plated, or stainless steel, concealed hinge, complete with springs, suitable for external dimensions of piping/insulation.

Secure to pipe or finished surface. For all pipes passing through suspended ceilings and uninsulated piping passing through walls. Outside diameter shall cover opening or sleeve.

.3 Where pipe sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.

.4 Do not install escutcheons and plates in concealed locations.

1.35 DUCT AND PIPE MOUNTED CONTROL EQUIPMENT

.1 The following automatic control equipment will be supplied under Section 23 09 01 but installed by the appropriate trade sections of Division 23:

.1 Automatic control valves.

.2 Temperature control wells.

.3 Pressure tappings.

.4 Flow switches.

.5 Automatic control dampers.

.6 Static pressure sensors.

.7 Flow stations (air/liquid).

.8 Pressure switches.

.9 Level indicators.

.10 Pressure differentials.

1.36 ELECTRIC MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 Unless noted otherwise, provide open drip-proof, ball bearing motors.

.3 Motors shall be UL listed and CSA certified.

.4 Full Voltage Start Applications:

.1 All motors shall be in accordance with NEMA standards, and CSA C390-93, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.

.5 Variable Frequency Drive and soft start applications:

.1 All motors shall be in accordance with NEMA standards (MG-1) Part 31, and inverter duty class, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.

.2 Motors connected to VFD(s) shall be wound using inverter spike resistant magnet wire capable of 1600V.

.6 Motors shall have standard voltage ratings consistent with the project distribution voltages. Motors less than 1/2 H.P. to be 120 volt, 60 cycle, single phase power. Motors 1/2 H.P. and larger to be 3 phase power and for the scheduled voltage.

.7 All motors shall be designed and manufactured to operate with ±10% voltage and ±5% frequency variations of the nameplate ratings. Combined voltage and frequency variation shall not exceed ±10%.

.8 The noise level of each motor shall comply with NEMA standards, <80 dBA at 1m.

.9 Motors will be rated for a 1.15 service factor in a 40°C ambient environment.

.10 All Motors, 1 H.P. motors and larger, shall be energy efficient design and have a minimum and nominal full load efficiency, which will meet or exceed the values listed in accordance with IEEE Test Procedure 112, Method B. Also see table below. The minimum efficiency shall be guaranteed. See table below for minimum efficiencies.

HP	**Minimum Efficiency (%)**		
	3600 RPM 2 Pole	**1800 RPM 4 Pole**	**1200 RPM 6 Pole**
1	75.5	82.5	80.0
1.5	82.5	84.0	85.5
2	84.0	84.0	86.5
3	85.5	87.5	87.5
5	87.5	87.5	87.5
7.5	88.5	89.5	89.5
10	89.5	89.5	89.5
15	90.2	91.0	90.2
20	90.2	91.0	90.2
25	91.0	92.4	91.7
30	91.0	92.4	91.7
40	91.7	93.0	93.0
50	92.4	93.0	93.0

.11 All motors to be standard 1800 RPM unless specifically scheduled otherwise.

.12 Provide all motors with terminal boxes, suitable for power connections.

.13 Provide screw adjustable bases on all belt connected motors.

.14 Motors to be of the capacitor start type when they may be manually cycled from a starting switch, which is located in the finished space.

.15 Motors exposed to outdoor temperature to be lubricated with lubricants suitable for operation at 6 deg. C. below the lowest temperature recorded by ASHRAE or the Climatic Information (Supplement to the National Building Code), for the location in which they are installed.

.16 Submit data of test method used, with shop drawings, when motor efficiencies are called for.

.17 Unless otherwise noted starters and protection devices will be included under the Electrical Division of the Specification.

.18 Assist Division 26 to ensure proper connection, correct thermal overload protection and correct motor controls.

.19 Where starters are included in this Division as an integral part of packaged equipment, they shall contain thermal overload protection in all ungrounded lines.

.20 Equipment, which has more than one voltage rating, shall be fed from a single power source through a disconnect switch.

.21 If delivery of specified motor will delay delivery or installation of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not be given until specified motor is installed.

1.37 BELT DRIVES

.1 Provide belt drives to the following requirements:

.1 Provide steel, cast iron or aluminum sheaves for motors less than 3/4 H.P.

.2 Provide steel or cast iron sheaves keyed to shafts, for motors 3/4 H.P. and larger.

.3 For motors less than 10 H.P. provide standard adjustable pitch drive sheaves having +/-10% range. Use mid-position of range for specified RPM.

.4 For motors 10 H.P. and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.

.2 Match drive and driven sheaves.

.3 V-belts shall conform with the American Belt Manufacturers standards. Multiple belts shall be matched sets.

.4 Not less than a 2-belt configuration is required for each drive for motors 3/4 H.P. and larger.

.5 Minimum drive rating shall be 150% of nameplate rating of motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.6 Motor slide rail adjustment baseplate with double draw bolt, shall allow for centre line adjustment.

.7 Tension belts to manufacturers recommendations before start up and after 100 hours of operation using calibrated belt tensioning gauge.

.8 Provide one spare set of belts for each piece of equipment with each belt separately identified for the equipment item to be served.

1.38 SHAFT COUPLINGS

.1 Shaft couplings shall be of the pin or jaw neoprene insert type, gear type, or flexing steel insert type and shall allow coupling inserts to be easily removed without disassembly of the equipment.

1.39 SETTING AND ALIGNMENT

.1 Employ a journeyman millwright to align all V-belt drives and/or shaft coupling drives prior to initial start up. The millwright shall also check that centrifugal fan wheels are properly centred on fan shafts.

.2 Align shaft couplings, using a dial indicator, to within +/-0.051 mm [0.002"] after grouting is complete and the piping system is operational.

.3 Align V-belt drives using a straight edge.

.4 Submit a certificate from the millwright employed, certifying that all shaft couplings and V-belt drives have been aligned and centrifugal fan wheels centred prior to initial start up and checked again after final system balance adjustment.

1.40 GUARDS

.1 Provide removable protective guards on all exposed V-belt drives and shaft couplings in accordance with Worker's Compensation Board requirements.

.2 Guards for drives shall have:

.1 1 mm [18 ga.] expanded metal screen welded to 25 mm [1"] steel angle frame.

.2 1.5 mm [16 ga.] thick galvanized sheet metal tops and bottoms.

.3 Removable side[s] for servicing.

.4 38 mm [1-1/2"] dia. holes on both shaft centres for insertion of tachometer.

.5 Sectionalize if necessary so one man can handle removal.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Fabricate and install belt guards for V-belt drives to permit movement of motors for adjusting belt tension and for belt slap.

.5 Provide removable "U" shaped guards for flexible couplings with 2.5 mm [12 ga.] thick galvanized frame and 1.2 mm [18 ga.] thick expanded mesh face.

.6 Provide guards on all unprotected fan inlets and outlets. Guards to be provided by fan manufacturer.

.7 Prime coat guards and finish paint to match equipment.

.8 Secure guards to equipment allowing for ease of removal.

1.41 EQUIPMENT SUPPORTS

.1 Provide stands and supports for equipment and materials supplied.

.2 Lay out concrete bases and curbs required under Division 23. Coordinate with respective division for all concrete work.

.3 Concrete bases shall be a minimum of 100 mm [4"] thick, or as noted and shall project at least 150 mm [6"] outside the bedplate, unless otherwise directed. Bases and curbs shall be keyed to the floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases at 45 degrees.

.4 Equipment with bedplates shall have metal wedges placed under the edges of the bedplates to raise them 25 [1"] above the base after levelling. The wedges shall be left permanently in place. Fill the space between the bedplate and the base with non-shrink grout - Embeco or In-Pakt.

.5 Construct equipment supports of structural steel or steel pipe. Securely brace. Employ only welded construction. Bolt mounting plates to the structure.

.6 Support ceiling hung equipment with rod hangers and/or structural steel.

1.42 DIELECTRIC COUPLINGS

.1 On all "OPEN" systems provide wherever pipes of dissimilar metals are joined.

.2 Provide insulating unions for pipe sizes NPS 2 and under and flanges for pipe sizes over NPS 2.

.3 Provide felt or rubber gaskets to prevent dissimilar metals contact.

.4 Standard of Acceptance: Capital, Walter Vallet, EPCO.

1.43 LUBRICATION OF EQUIPMENT

.1 Lubricate all new equipment prior to being operated, except sealed bearings, which shall be checked.

.2 Use the lubricant recommended by the manufacturer for the service for which the equipment is specified.

.3 Extend lubricating connections and sight glasses to the outside of housings, where lubricating positions are not readily accessible.

.4 Submit a check list, showing that all operated equipment has been lubricated prior to and during any temporary heating period and the demonstration and instruction period.

1.44 PAINTING

.1 Clean exposed bare metal surfaces supplied under Division 23, removing all dirt, dust, grease and millscale. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.

.2 Paint all pipe hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer, as they are installed.

.3 Repaint all marred factory finished equipment supplied under Division 23, to match the original factory finish.

.4 Coordinate with respective division for painting.

.5 Painting of all equipment and materials, supplied under Division 23, installed in mechanical equipment areas and inside finished areas of the building or exposed outside the building, is included under respective painting division of the Specification.

.6 Painting by respective Division shall be in accordance with the following Colour Schedule for Mechanical Equipment Areas:

Item	Colour Finish
Boiler Shells and Boiler Control Panels	Blue
Boiler Supports	White
Breeching (uninsulated)	Aluminum (high temp.)
Piping (uninsulated)	
• gas (natural)	Yellow
• services other than above	White
Pot Feeders (Chemical)	Aluminum
Pump Bodies (uninsulated) and bases	Blue
Tanks and Supports	White
Valve Bodies (uninsulated)	
• hot water heating	Aluminum (high temp.)
• services other than above	To match associated piping

1.45 CLEAN-UP FOR PAINTING

.1 Clean all exposed bare metal surfaces furnished under this Division by removing all dirt, dust, grease and millscale. Painting of all equipment and materials installed in mechanical equipment areas will be by others.

.2 All miscellaneous metal work furnished under this Division shall be supplied with one shop coat of primer for finished enamel painting. After erection or installation, whichever is appropriate, apply one coat of undercoat in readiness for finish painting. Preparatory work on all surfaces, prior to painting, shall be in accordance with the recommendations of the paint manufacturer.

1.46 EXISTING SERVICES

.1 Protect all existing services encountered. Every effort has been made to show the known existing services. However, the removal of concealing surfaces may reveal other existing services. Work with the Departmental Representative's staff to trace the originating source and points served. Obtain instructions from the Departmental Representative when existing services require relocation or modifications, other than those already indicated in the Contract Documents.

.2 Arrange work to avoid shutdowns of existing services. Where shutdowns are unavoidable, obtain the Departmental Representative's approval of the timing, and work to minimize any interruptions.

.3 Shutdowns, to permit connections, will be carried out by maintenance staff.

.4 In order to maintain existing services in operation, temporary relocations and/or bypasses of piping and ductwork may be required.

.5 Be responsible for any damages to existing systems by this work.

1.47 RE-USED EQUIPMENT

.1 Where existing equipment is being relocated and re-used, check and report on the condition to the Departmental Representative before reinstallation.

1.48 DEMOLITION

.1 Reference Standards

.1 Unless otherwise specified, carry out demolition work in accordance with CAN/CSA-S350-M (latest edition), Code of Practice for Safety in Demolition of Structures.

.2 Existing Conditions

.1 Visit and examine the site and note all characteristics and irregularities affecting the work of this section.

.3 Protection

.1 Cease operations and notify the Departmental Representative immediately for special protective and disposal instructions when any asbestos materials are uncovered during the work of this section.

.2 Prevent debris from blocking surface drainage inlets and mechanical and electrical systems, which remain in operation.

.4 Salvageable Materials

.1 Except as otherwise indicated, salvageable materials from areas of demolition shall become the property of the Departmental Representative at his discretion. All material removed from the building not handed over to the Departmental Representative for salvage under this project shall be removed from site and disposed of as required by any applicable disposal regulations.

.5 Existing Services

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

.2 Maintain all building services as required during demolition/removal of existing.

.6 Demolition

.1 Carry out demolition in a manner to cause as little inconvenience to the adjacent occupied building area as possible. Coordinate the activity with the Departmental Representative.

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

.3 All removal of existing equipment, pipes and ductwork that may affect occupied areas of the building to be done outside of regular office hours or as scheduled with the Departmental Representative.

1.49 PROJECT CLOSE-OUT REQUIREMENTS

.1 The project closeout requirements are specifically listed in each section of this specification. The following is a summary of those requirements. Refer to detailed specifications in each section for further, detailed requirements. Also refer to Section 23 06 02 (Forms MF-188 and MF189) for list of required HVAC substantial completion submissions. Items designated with an asterisk are required to be submitted one week prior to required date of Schedule C. All life safety systems must be operational and tested and demonstrated to Consultant prior to issuance of Schedule C. This includes items such as fire pump, sprinklers, stair pressurization fans, smoke exhaust system, parkade exhaust CO system (as applicable).

.1 Controls:

- Controls system completion report (check sheets).
- Controls system final electrical approval certificate.
- As built control drawings.
- Control training signed off by Departmental Representative (indicate dates of training in letter and attendance).
- List of control manuals and documents turned over.
- Printed copy of control program and database. Printed to disk in Word format acceptable.
- Disc of control system database.

.2 Heating/Cooling

- Boiler Inspection Branch certificate.
- Gas fired appliances/gas line/pressure piping certificate.
- Registration certificates for all pressure vessels.
- Pressure test reports for heating lines.

- Vibration isolation report.
- Seismic inspection report.
- Valve tag chart.
- As built drawings.
- Welding certificate and x-ray reports.
- Flushing and cleaning of piping report.

.3 HVAC

- Fire damper test report letter and schedule.
- As built drawings.

.4 Miscellaneous

- Identification Schedules.
- Seismic Engineer's Letters of Assurance
- Demonstrations to Departmental Representative signed off by Departmental Representative.
- List of incomplete or deficient work prepared by each sub trade.
- Contractor's Letter of Guarantee
- Signed-off substantial completion inspection report.
- List of spare parts signed off by Departmental Representative.

.5 Manufacture start-up and other reports including:

- Water Balance.
- Commissioning.
- Fire stop letter of assurance.
- Boilers
- Heating chemical treatment.
- VFDs

1.50 START-UP

.1 Before starting the plant, provide a certificate stating that the plant is ready for start-up and the following conditions have been met. (See forms in Section 23 06 02).

.1 All safety controls installed and fully operational.

.2 Qualified personnel available to operate the plant.

.3 Permanent electrical connections made to all equipment.

.4 Boiler(s) started up and adjusted by manufacturer's representatives.

.5 All air filters installed.

.6 Pump and fan drives properly aligned by a journeyman millwright.

.7 All mechanical equipment rooms, including plenums, vacuum cleaned.

1.51 SPARE PARTS

.1 Provide spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One glass for each gauge glass installed.

.4 One set of V-belts for each piece of machinery.

.5 One filter cartridge for each filter installed (pre and final filters).

1.52 CLEANING AND FINAL ADJUSTMENT

.1 Clean mechanical systems daily.

.2 Clean interior and exterior of all systems including strainers, and vacuuming of interior of ductwork, air handling units.

.3 Clean and refurbish all equipment and leave in first class operating condition including replacement of all filters in all air and piping systems.

.4 Balance and adjust all systems and each piece of equipment to operate efficiently.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

Part 2 Products

2.1 GENERAL

.1 Select thermometers and pressure gauges so that their operating range falls in the middle half of the scale range.

2.2 THERMOMETERS - PIPING

.1 Acceptable Manufacturers:

.1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.

.2 Minimum Requirements:

.1 All thermometers to be in accordance with Canadian General Standards Board CGSB 14.4 - M88.

.2 Pipe mounted stem type - mercury actuated, adjustable angle type.

.3 Refer to flow schematics for location of pipe mounted thermometers and wells.

.3 Case:

.1 Stem type - cast aluminum alloy, either anodized or coated with baked enamel. The case shall be provided with a clear glass or heat resistant plastic window. Also coordinate with Control Contractor for any other required wells.

.4 Scale:

.1 Stem type - 225 mm [9"] scale length.

.2 White background with temperature range in black.

.3 Dual Celsius and Fahrenheit scale.

2.3 PRESSURE GAUGES - PIPING

.1 Acceptable Manufacturers:

.1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.

.2 Minimum Requirements:

.1 All gauges to be in accordance with ANSI B40.1 Grade "A" level.

.2 115 mm [4-1/2"] cast aluminum, black steel or stainless steel case, with stainless steel or chrome plated face ring.

.3 White background with pressure range in black.

.4 Dual kilopascal and psig scale.

.5 Phosphor bronze bourdon tube, silver brazed tip and socket 1/4" NPT lower connection.

.6 Rotary type bushed movement, silicone dampened to prevent pointer oscillation.

.7 Gauges to be registered with Provincial Boiler and Pressure Vessel Safety Branches with CRN number.

.8 ULC listed for use on fire protection systems.

.9 Accuracy shall be 1% off full scale over the middle half of the scale.

.3 Accessories:

.1 Install a needle valve ahead of each gauge.

2.4 TEST THERMOMETER

.1 Hand over a test thermometer in protective case to the Owner during the Owner's Demonstration and Instruction Period. Provide the same make and type as the permanently installed thermometers suitable for use with pipe mounted wells. Range 0 deg. C. to 115 deg. C. [30 deg. F. to 240 deg. F.].

.2 Obtain two signed receipts from the Owner certifying that the test thermometer has been received. Hand one over to the Departmental Representative.

2.5 THERMOMETER WELLS

.1 For copper pipe use copper or bronze. For steel pipe use brass, separable socket, 3/4 NPT.

.2 Thermowell to be registered with Provincial Boiler and Pressure Vessels Safety Branch with CRN number.

Part 3 Execution

3.1 GENERAL

.1 Install thermometers and gauges so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading thermometers and gauges.

.2 Install engraved lamicoid nameplates as specified in Section (23 05 53 - Identification) identifying medium.

3.2 THERMOMETERS

.1 Install in wells on all piping.

.2 Install the separable well so as to minimize the restriction to flow and, if necessary, install in a section of oversized pipe.

.3 Install wells where indicated for use with test thermometers.

.4 Install in locations as indicated and on inlet and outlet of:

.1 Water boilers.

.2 As shown on schematic drawing.

.5 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

.1 Install in following locations:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 In other locations as indicated.

.2 Use extensions where pressure gauges are installed through insulation.

.3 Where a single gauge is used to measure multiple points provide needle valves to isolate each point, including pressure gauge.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.

.2 Set inserts in position in advance of concrete work. Use grid system in equipment rooms.

.3 Support from (top of) structural members. Where structural bearings do not exist or inserts are not in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members, as necessary.

.4 Do not suspend from metal deck.

.5 Hangers for copper pipe shall be copper plated or plastic dipped unless pipe hangers bear on piping insulation (cold services).

Part 2 Products

2.1 UPPER ATTACHMENTS

.1 Concrete:

.1 Inserts for cast-in-place concrete: galvanized steel wedge. ULC listed for pipe NPS 3/4 through NPS 8 - Grinnell/Anvil Fig. 281.

.2 Carbon steel plate with clevis for surface mount: malleable iron socket with expansion case and bolt. Minimum two expansion cases and bolts for each hanger –Grinnell/Anvil, plate fig. 49, socket fig. 290, expansion case fig. 117.

.2 Steel Beam (bottom flange):

.1 Cold piping NPS 2 and under: malleable iron C clamp - Grinnell/Anvil fig. 61.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: malleable iron beam clamp - Grinnell/Anvil fig. 292.

.3 Steel Beam (top):

.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp - Grinnell/Anvil Fig. 61.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.

.4 Steel Joist:

.1 Cold piping NPS 2 and under: steel washer plate with double locking nuts - Grinnell/Anvil fig. 60.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket - Grinnell/Anvil: washer plate, fig. 60; clevis, fig. 66; socket, fig. 290.

.5 Steel Channel or Angle (bottom):

.1 Cold piping NPS 2 and under; malleable iron C clamp - Grinnell/Anvil fig. 86.

.2 Cold piping NPS 2-1/2 and larger and all hot piping; universal channel clamp - Grinnell/Anvil fig. 226.

.6 Steel Channel or Angle (top):

.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp - Grinnell/Anvil fig. 61.

.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.

2.2 MIDDLE ATTACHMENTS (ROD)

.1 Carbon steel black (electro-galvanized/cadmium plated for mechanical rooms) continuous threaded rod - Grinnell/Anvil fig. 146 or Myatt fig. 434.

2.3 PIPE ATTACHMENTS

.1 Cold piping, steel or cast iron: hot piping steel, with less than 25 mm [1"] horizontal movement; hot piping, steel, with more than 300 mm [12"] middle attachment (rod) length: adjustable clevis - Grinnell/Anvil fig. 260.

.2 Cold copper piping; hot copper piping with less than 25 mm [1"] horizontal movement; hot copper piping with more than 300 mm [12"] middle attachment (rod) length: adjustable clevis copper plated - Grinnell/Anvil fig. CT-65.

.3 Suspended hot piping, steel and copper, with horizontal movement in excess of 25 mm [1"]; hot steel piping with middle attachment (rod) 300 mm [12"] or less; pipe roller - Grinnell/Anvil fig. 174 or Grinnell/Anvil fig. 181 up to NPS 6 and Grinnell/Anvil fig. 171 NPS 8 and larger.

.4 Bottom supported hot piping, steel and copper: pipe roller stand - Grinnell/Anvil fig. 271.

.5 Spring hangers; where required to offset expansion on horizontal runs which follow long vertical risers - Grinnell/Anvil fig. 171 single pipe roll hanger with Grinnell/Anvil fig. 178.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel - Grinnell/Anvil fig. 261 or Myatt fig. 182.

.2 Copper pipe: carbon steel copper finished - Grinnell/Anvil fig. CT-121.

2.5 SADDLES AND SHIELDS

.1 Cold piping NPS 2 and under: protection shield with pipe insulation under shield with uninterrupted vapour barrier – Kingspan “K Block” – high density insulation

.2 Cold piping NPS 2-1/2 and over: protection shield with high density insulation under shield with uninterrupted vapour barrier – Kingspan “K Block” – high density insulation.

.3 Hot piping NPS 3 and under: insulation over pipe hanger.

.4 Hot piping NPS 4 and over: protective saddle with insulation under saddle - Grinnell/Anvil fig. 160 to 166.

2.6 WALL SUPPORTS

.1 Horizontal pipe adjacent to wall:

.1 Angle iron wall brackets with specified hangers.

.2 Vertical pipe adjacent to wall.

.1 Exposed pipe wall support for lateral movement restraint - Grinnell/Anvil fig. 262 or 263.

.2 Channel type support - Burndy, Canadian Strut, Cantruss or Unistrut - (arrangement to be acceptable to B.C. Boiler Inspection Department).

2.7 FLOOR SUPPORTS

.1 Horizontal pipe.

.1 Do not support piping from the floor unless specifically indicated.

.2 Vertical pipe.

.1 Mid-point of risers between floor slabs - adjustable fabricated steel supports. Refer to Section 23 05 49 Seismic Restraints.

Part 3 Execution

3.1 HANGER SPACING

.1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.

.1 Plumbing piping: most stringent requirements of the Plumbing Code or authority having jurisdiction.

.2 Fire protection: to applicable fire code; toggle hangers are unacceptable.

.3 For Gas Piping refer to Gas Code CAN/CGA-B149.1.

.4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

.5 Within 300 mm [12"] of each horizontal elbow.

.2 Maximum hanger spacing table.

Pipe Size: NPS	Rod Diameter mm [ins]	Maximum Spacing Steel Pipe m [ft]	Maximum Spacing Copper Pipe m [ft]
½	10 [3/8]	1.8 [6]	1.5 [5]
¾, 1	10 [3/8]	2.4 [8]	1.8 [6]
1¼ , 1½	10 [3/8]	3.0 [10]	1.8 [6]
2	10 [3/8]	3.0 [10]	3.0 [10]
2½ , 3, 4	12 [1/2]	3.0 [10]	3.0 [10]
5, 6, 8	16 [5/8]	3.0 [10]	
10, 12	22 [7/8]	3.0 [10]	

3.2 HANGER INSTALLATION

.1 Offset hanger so that rod is vertical in operating position.

.2 Adjust hangers to equalize load.

.3 Install hanger to provide minimum 12 mm [½"] clear space between finished covering and adjacent work.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts. Provide vibration isolation on all motor driven equipment, piping and ductwork such that noise transmitted to occupied space by any other path than airborne is less than airborne noise transmitted from mechanical space to occupied space. The following are considered minimum requirements to meet this criterion.

1.2 REGULATORY REQUIREMENTS

.1 Supply isolators and seismic restraints meeting the structural requirements of the National Building Code of Canada 2015, Division B, including Section 4.1.8.17. with respect to seismic snubbers, or provide equivalent requirements where integral seismic restraint is provided in isolators / bolting.

.2 Include National Building Code of Canada 2015, Division B, Section 6.2.1.8. (2) Vibration isolator housings are considered a safety guard with respect to isolated equipment and any contained compressed springs. Include "Fail Safe" seismic restraint in all vibration isolation designed to hold mechanical equipment and springs in place.

1.3 SHOP DRAWINGS, QUALIFICATIONS AND SUBMITTALS

.1 Anchorage of all equipment shall be certified by a B.C. registered professional structural engineer who specializes in seismic restraint of resiliently mounted systems. All seismic integral isolation mounts or snubbers shall be O.S.H.P.D. (Office of Statewide Health and Planning Department – State of California) approved and the associated OSHPD number clearly indicated on the seismic device. Where OSHPD certification is not available for a particular restraint device, results of tests consistent with OSHPD procedures and approvals shall be submitted and certified by a B.C. registered professional structural engineer

.2 Obtain all relevant equipment information and provide shop and placement drawings for all vibration isolation elements and steel bases for review before materials are ordered.

.3 Provide attachment to both the equipment and the structure meeting the specified forces involved. Attachment details to the structure to be reviewed by the structural Engineer for the project.

.4 Submit samples of materials required to complete the work of this section for inspection and review, if and when requested.

1.4 GENERAL

.1 Provide vibration isolation on all motor driven equipment with motors of 1/2 HP and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than 1/2 HP, provide vibration isolation grommets at the support points.

.2 Provide seismic restraint for all equipment including all seismic restraint related hardware (bolts and anchors) from point of attachment to equipment through to and including attachment to structure. The required anchors shall be indicated on the shop drawings and shall be clearly identified for the correct location and so as to be readily identified after installation. Provide clear instructions for their installation. Refer to Section 23 05 49, Seismic Restraints.

.3 Place isolators under equipment so that the minimum distance between adjacent corner isolators is at least equal to the height of the centre of gravity of the equipment. Include height of centre of gravity on shop drawings. Otherwise, design for increased forces on the supports, and submit design calculations with shop drawings for approval. In particular, provide chiller isolation meeting this requirement.

.4 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness correction factors for elastomers and do not exceed 60 durometer.

.5 Isolators and restraining devices, which are factory supplied with equipment, shall meet the requirements of this section. Isolation supplier to check with pump supplier for number and location of isolators and if there is a requirement for structural or inertia bases.

.6 Coordinate with Division 3 for the provision of housekeeping pads at least 100 mm [4"] high under all isolated equipment, or greater thickness where specified. Provide at least 300 mm [12"] clearance between drilled inserts and edge of housekeeping pads. Housekeeping pads to be tied to structure with reinforcement to meet Code seismic requirements.

.7 For isolated equipment, design anchors, bolts, isolators and bases to meet Code requirements. For larger isolators, where the Code requirement cannot be met by the isolator housing, provide Type 6 seismic snubbers or Type 6P where post-disaster requirement is specified.

.8 Use ductile materials in all vibration and seismic restraint equipment.

.9 Follow structural Engineer's instructions for drilled inserts re: installation of anchors.

.10 Coordinate with Section 23 33 00 "Duct Accessories" for all ductwork connections to fans or plenums.

.11 Provide flexible connectors between equipment and piping where required by manufacturers to protect equipment from stress and reduce vibration in the piping system. Meet connector manufacturer's installation specifications as well as equipment manufacturer's requirements.

.12 Coordinate with Division 26 for the provision of a minimum 180° hanging loop of flexible conduit for all electrical connections to isolated equipment.

.13 Supply all isolators fully assembled and clearly labelled with full instructions for installation by the contractor.

Part 2 Products

2.1 ISOLATORS - GENERAL

.1 Supply all of the vibration isolation equipment by one approved supplier with the exception of isolators, which are factory installed and are standard equipment with the machinery. Confirm with manufacturer that these factory-installed isolators meet the seismic requirements of this specification.

.2 Select isolators at the supplier's optimum recommended loading and do not load beyond the limit specified in the manufacturer's literature.

.3 Design springs in accordance with the Society of Automotive Engineers' Handbook Supplement 9 entitled "Manual on Design and Application of Helical and Spiral Springs - SAE", the latest edition. Provide neoprene isolators and components using maximum 60 duro "Bridge bearing quality neoprene", as defined by CSA Standard CAN3-S6-M78 Section 11.10. Ensure design of isolation and restraint elements allows adequate clearance to avoid binding.

.4 Design springs "iso-stiff" (kx/ky = 1.0 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.

.5 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for all isolation equipment located out of doors or in areas where moisture may cause corrosion.

2.2 ISOLATORS - TYPE 1, PADS

.1 Neoprene or neoprene / steel / neoprene pad isolators. Select Type 1 pads for a minimum 2.5 mm [0.1"] static deflection or greater. Use hold down bolts selected for seismic loads. Isolate bolts from base of unit using neoprene hemi-grommets. Avoid over-compressing grommets (e.g. use Hilti HVA adhesive set bolts, or equal, with steel washers and lock nuts, adjusted finger tight to the hemi-grommets). Size bolt and hemi-grommet for minimum lateral clearance. Use grommets only on light-weight equipment.

.2 Standard of Acceptance:

.1 Mason WMW, Super W pads

.2 Mason Industries Type HG Hemi-Grommets

.3 EAR Grommets

2.3 ISOLATORS - TYPE 2, RUBBER FLOOR MOUNTS

.1 Rubber/neoprene-in-shear isolators designed to meet specified seismic requirements. Select isolators for a 4 mm [0.15"] minimum static deflection, and bolt to structure. In the case of rubber isolators, provide protection in the design of the isolator to avoid contact of the rubber element to oil in the mechanical room.

.2 Standard of Acceptance

.1 Mason BR, maximum 50 durometer.

2.4 ISOLATORS - TYPE 3, SPRING FLOOR MOUNTS

.1 Spring mounts complete with levelling devices, selected to achieve 25mm deflection under load, Springs to incorporate a minimum 6 mm [1/4"] thick neoprene sound pad or cup having a 1.3 mm [0.05"] minimum deflection under load. Design isolator to meet specified seismic requirements.

.2 Standard of Acceptance:

.1 Mason SSLFH.

2.5 ISOLATORS - TYPE 4, HANGER MOUNTS

.1 Spring hangers, c/w 6 mm [1/4"] thick neoprene cup/bushing sized for 1.3 mm [.05"] minimum deflection, or neoprene hangers.

.2 Standard of Acceptance:

.1 Mason HD, HS.

2.6 ISOLATORS - TYPE 6, SEISMIC SNUBBERS.

.1 Seismic snubbers c/w minimum 3mm [1/8"] neoprene bushing and 6mm [1/4"] air gap. Snubber to act omni-directionally. Ensure bushing can easily be turned by hand after installation

.2 Standard of Acceptance:

.1 Manson Z-1225.

2.7 CLOSED CELL FOAM GASKETS / NEOPRENE GROMMETS - TYPE 7

.1 20 mm [3/4"] thick continuous perimeter closed cell foam gasket to isolate base of package type equipment, AHU's, exhaust fans, etc. from concrete floors / roof curbs. Select width for nominal 3psi loading under weight of equipment and allow for 25% compression 5mm [3/16"]. Increase width of curb using steel shim if necessary to accommodate gasket. For light equipment such as exhaust fans, deflection should be a minimum of 0.05". Contractor to check fire rating requirements specified for project.

.2 Standard of Acceptance:

.1 American National Rubber-EPDM-SBR blend SCE 41 type neoprene.

.2 Mason Industries Type HG Hemi-Grommets.

2.8 PIPE RISER GUIDE / ANCHOR - TYPE 8

.1 Telescoping all direction acoustical pipe anchor consisting of two concentric steel tubes separated by 12 mm thick neoprene isolation material. Hot application isolators.

.2 Standard of Acceptance:

.1 Mason ADA and VSG (H).

.2 PRV stations, etc - CMT VA 50247/25 Cushions, CMT W302 isolators.

2.9 FLEXIBLE CONNECTORS – TYPE 9

.1 Twin sphere flexible connectors with floating flanges c/w control rods

.2 Standard of Acceptance:

.1 Mason MFTNC Connector.

.2 Mason ACC Control Cables.

Part 3 Execution

3.1 INSTALLATION

.1 Execute the work in accordance with the specifications and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.2 For all equipment mounted on vibration isolators, provide a minimum clearance of 50 mm [2"] to other structures, piping, equipment, etc.

.3 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing (seismically rated) anchors and/or welding.

.4 After installation and adjustment of isolators verify deflection under load to ensure loading is within specified range and isolation is being obtained.

.5 Where hold down bolts for isolators or seismic restraint equipment penetrate roofing membranes, provide "gum cups" and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene. Co-ordinate with roofing section of specifications and with roofing subcontractor.

.6 Under equipment mounted on Type3 mounts, which do not meet the seismic requirement, provide Type6 seismic snubbers.

.7 Use Type 1 pads only where specified.

.8 Isolate all floor or pier mounted equipment on Type 3 isolators, unless otherwise specified.

.9 Isolate pumps and axial fans rotating at more than 1170 RPM on type 2 isolators.

.10 Use the lowest RPM scheduled for two speed equipment in determining isolator deflection.

.11 Ensure that pumps are installed and aligned such that no piping loads are imposed on the pump. Pumps and piping should be independently supported and aligned prior to final connection.

.12 For equipment mounted on a slab on grade mount on type 2 isolators unless otherwise specified.

.13 Mount in-line pumps on two (2) Type 2 isolators under each support foot.

.14 Select Type 4 spring hangers for a minimum static deflection of 25 mm [1"] for all ceiling hung fans, and air handling units.

.15 Provide Type 4 resilient hangers on all piping, tanks, etc. connected to a vibrating source, if the piping is in excess of NPS 1-1/2 dia. Provide the hangers for a distance of 6.0 m [20 ft] for a NPS 2 pipe and 12 m [40 ft] for a NPS 10 pipe. Isolate other pipe sizes for a proportionate distance.

.16 Where ductwork, piping or boiler exhaust stacks, etc., connected to or serving noise generating equipment is routed through walls, floors, piping chases, etc. position ductwork, piping, stacks, etc. to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Use Type 2 and Type 8 mounts. Submit proposed details to meet this requirement.

.17 Make no connections between mechanical room equipment and drywall partitions, adjoining occupied spaces. Mount all equipment designed for wall mounting on non-critical, block work or concrete walls. Connect hangers to concrete structure only. Where structure is steel, connect to major structural beams only, or to structural angles with gussets attached to concrete shear walls. Do not attach to light framing members such as OWSJ's. Do not connect to edge of beam flange (e.g. with clips). Weld nut or threaded sleeve to bottom flange at centre, directly below web, to accommodate threaded hanger rod.

.18 Provide Type 8 resilient elements in pipe anchors, where pipe anchors are within 12 m [39 ft.] of a vibrating source or if located in pipe chases.

.19 Protect neoprene isolator components from overheating or use type 8 mounts.

.20 Be responsible for ensuring that flexible duct connections (see Section 15820) are installed with a minimum of 40 mm [1-1/2"] metal to metal gap. Use flanges to ensure that flexible connectors are clear of the airstream.

.21 Isolate variable frequency drive controller using isolators or soft grommets such that structure borne noise transmission to occupied space is less than airborne noise transmission. Controller supplier to provide all isolation, including wiring connections, to control flanking noise transmission. Provide isolation meeting all seismic requirements.

.22 Provide stabilizing springs limiting movement at flexible connections to 25% of fabric width under steady state conditions and 40% at start up.

3.2 INSPECTIONS

.1 The supplier shall provide assistance to the contractor as necessary during the course of installation of isolation equipment.

.2 The supplier shall inspect the complete installation after system startup and establish that the isolators for each piece of equipment are properly installed and adjusted. Correct any mal-performance. The supplier shall submit a statutory declaration to the Departmental Representative stating that the complete vibration isolation installation is installed in accordance with his drawings and instructions and operates to his satisfaction. Form MF175 in Section 23 06 02 should be used for this purpose.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REGULATORY REQUIREMENTS

.1 Restraints shall meet the requirements of the National Building Code of Canada 2015, Division B, Section 4.1.8.17., table 4.1.18.17.

1.3 SEISMIC RESTRAINT DESIGN AND INSPECTION

.1 Arrange and pay for the services of a B.C. registered professional structural engineer who specializes in the restraint of building elements. This structural engineer, herein referred to as the Seismic Engineer shall provide all required engineering services related to seismic restraints of non-vibration isolated equipment, ductwork and piping as indicated below.

.2 The Seismic Engineer shall provide assistance to the contractor as necessary during the course of restraint of equipment, ductwork and piping.

.3 The Seismic Engineer shall inspect the completed seismic installation and shall submit a statutory declaration to the Departmental Representative stating that the complete seismic installation is installed in accordance with his drawings and instructions and it complies with the regulatory requirements. Form MF174 in Section 23 06 02 should be used for this purpose. The Seismic Engineer shall submit Schedules B and C once inspection is completed.

1.4 SUBMITTALS

.1 Submit shop drawings of all restraining devices, not covered in the SMACNA Guidelines, including details of attachment to the structure, either tested in an independent testing laboratory or approved by a B.C. registered professional engineer.

.2 Proposed inserts or connections to structure to follow directions of project structural Engineer.

1.5 APPLICATION

.1 Provide cable restraints on all isolated equipment and seismic restraint on all other equipment, piping and ductwork, all in general accordance with SMACNA Guidelines (see Products).

1.6 SCOPE OF WORK

.1 Provide restraint on all piping, ductwork, equipment and machinery which is part of the building mechanical service systems to prevent injury or hazard to persons and equipment and to retain equipment in its normal position in the event of an earthquake. This specification covers equipment which is not specifically covered in SMACNA.

.2 Provide all seismic restraint related hardware, (including bolts and anchors) from point of attachment to equipment through to and including attachment to structure.

.3 When equipment is mounted on concrete housekeeping pads, and / or concrete curbs the anchor bolts shall extend through the pad into the structure.

.4 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

.5 Seismic restraints may only be omitted where permitted by SMACNA.

Part 2 Products

2.1 General

.1 Mason Type SCB (Seismic Cable Brace) slack cable restraints supplied by Vibra-Sonic Control.

.2 Restraint systems as indicated in 1998 SMACNA "Seismic Restraint Manual Guidelines for Mechanical Systems" (second edition), Addendum #1 – 2000, Seismic Hazard Level SHL A. If lesser restraint than recommended by SMACNA SHL A is proposed to meet local Code seismic requirements, provide shop drawings of details certified by a B.C. registered Structural Engineer.

Part 3 Execution

3.1 General

.1 It is the responsibility of the contractor to ascertain that an appropriate size device be selected for each individual piece of equipment.

.2 The following are guidelines for some items not covered in SMACNA but certified shop drawings should still be submitted. Note that this list is not intended to cover all equipment requiring restraints.

3.2 NON-ISOLATED FLOOR MOUNTED EQUIPMENT

.1 Bolt all non-isolated equipment and machinery, e.g. floor mounted tanks, boilers, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the centre of gravity. For equipment which may be subject to resonances, use a nominal 2.0g seismic force.

3.3 ISOLATED PIPING AND EQUIPMENT

.1 Install cables using appropriate grommets, shackles, and other hardware to ensure alignment of the restraints and to avoid bending the cables at connecting points.

.2 Connect slack cable restraints to ceiling hung equipment in such a way that the axial projection of the wires passes through the centre of gravity of the equipment.

.3 Vary adjacent spacing of restraints on a piping run by 10% to 30% to avoid coincident resonances.

.4 Install restraints at least 50 mm [2"] clear of all other equipment and services.

.5 Adjust restraint cables such that they are not visibly slack, or such that the flexibility is approximately 40 mm [1-1/2"] under thumb pressure for a 1.5 m [5 ft] cable length (equivalent ratio for other cable lengths). Adjust the clearance at cable strap/spacer piece restraints to not exceed 6 mm [1/4"].

.6 Provide transverse and axial restraints as close as practical to a vertical bend.

.7 At steel trusses, connect to top chords and follow truss manufacturer's instructions.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 EQUIPMENT

.1 Manufacturer's Nameplates

.1 Each piece of manufactured equipment shall have a metal nameplate, with raised or recessed letters. Mechanically fasten plate to equipment.

.2 Manufacturer's nameplates shall indicate manufacturer's name, equipment model, size, serial number and electrical characteristics and pertinent information for any other services connections.

.3 Include ULC, (Underwriters' Laboratories Canada) and CSA, (Canadian Standards Association) registration logos and those of other agencies, as required by the respective agencies.

.4 Nameplates shall be located so that they are easily read. Do not insulate or paint over nameplates.

.2 System Nameplates

.1 Each piece of equipment shall be identified with its equipment schedule identification, e.g. supply fan SF-1, heating coil HC-1, pump P-1.

.2 Identification letters shall be 50 mm [2"] high black letters on a white background, sized to suit the label or, provide laminated plastic plates with black face and white centre of minimum size 90 mm x 40 mm x 2.5 mm [3-1/2" x 1-1/2" x 3/32"] engraved with 6 mm [1/4"] high lettering. Use 25 mm [1"] high lettering for major equipment.

.3 Apply nameplates securely in conspicuous places, on cool surfaces.

.4 Identify systems, and areas or zones of building being serviced.

1.3 PIPING

.1 Piping Identification

.1 Each piping system shall be colour coded for identification and labelled with the system identification code letters, including temperature and pressure, if applicable, and directional flow arrows in accordance with the Pipe Identification Colour Schedule. See diagram for sizes of lettering and bands.

.2 Identify piping adjacent to valves and where valves are in series at no more than 2 m [6'-6"] intervals. Identify piping at least once in each room and at 15 m [50 ft.] maximum spacing in open areas. Exception: gas piping to be identified at 2 m [6'-6"] intervals in ceiling plenums.

.3 Identify piping both sides where piping passes through walls, partitions and floors.

.4 Identify piping at point of entry and leaving each pipe chase and/or confined space.

.5 Identify piping accessible at each access opening.

.6 Identification labels may be stencilled. Identification arrows labels and letters may be vinyl cloth (Brady B500) or vinyl film (Brady B946), with adhesive compatible with the surface temperature.

.7 Identification colour bands for primary and secondary colours to indicate the type and degree of hazard shall be applied to overlap a minimum of 150 mm [6"]. Ends to be stapled. Bands shall be Brady B550 vinyl cloth tape or Brady B946 vinyl tape, with adhesive compatible with the surface temperature.

.2 Valve Tags

.1 Provide valve identification tags and secure them using non-ferrous chain braided band or plastic band (suitable for temperature). Tags may be of brass, aluminum, metalphoto, lamicoid or fiberglass, stamped or engraved, of 25 mm [1"] minimum diameter.

.2 Valves to be tagged include:

.1 Valves on <u>all</u> main piping circuits.

.2 Valves on all major branch lines.

.3 Valves on minor branch lines in horizontal service spaces, vertical service spaces and mechanical equipment rooms.

.4 DO NOT TAG valves on control valve stations, steam trap stations, fixture stops, system drain valves.

.5 Drain valves and hose bibbs on systems containing glycol.

.6 Control valves.

.3 Schedule the valve numbers using a sequential numbering system indicating location, service and normal position (open or closed).

1.4 CEILING ACCESS

.1 Secure 6 mm [1/4"] self-adhesive coloured dots, (Brady Quik Dots or Avery Data Dots), to the ceiling, to identify the location of access to equipment concealed above the ceiling according to the following schedule:

	Colour
Concealed equipment and cleaning access	yellow
Control equipment, including control valves, dampers and heat sensors	black
Fire, smoke and sprinkler equipment	red
Pipe mounted equipment, other than fire, smoke and sprinkler equipment	green

.2 When T-bar ceilings are installed adhere coloured dots to T-bar framing, adjacent to panel to be removed.

1.5 TAGGING IDENTIFICATION

.1 Secure engraved laminated plastic identification tags (black face and white centre) on the following items:

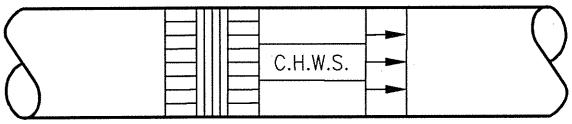
.1 Temperature control instruments, gauges and panels, coordinated with control diagrams identification.

.2 Electrical switchgear supplied under Division 23.

1.6 PIPE IDENTIFICATION COLOUR SCHEDULE

Service	Identification Lettering	Primary Colour	Secondary Colour
Hot Water Return	H.W.R.	yellow	black
Hot Water Supply	H.W.S.	yellow	black
Natural Gas	Gas	yellow	orange

1.7 PIPE IDENTIFICATION BANDING COLOURS



.1 LETTERS:

.1 13 mm [1/2"] high - 1-1/4 NPS pipe & smaller.

.2 25 mm [1"] high - 1-1/2 NPS up to 2-1/2 NPS pipe.

.3 50 mm [2"] high - 3 NPS and larger pipe.

.2 BANDS:

.1 38 mm [1-1/2"] wide, except arrow bands 50 mm [2"] wide.

.3 COLOURS:

.1 horizontally hatched - primary colour.

.2 vertically hatched - secondary colour.

.3 black letters and arrows on yellow primary colour.

.4 background, white letters and arrows or red, blue or green backgrounds.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Refer to Cx – Commissioning Plan in Appendix 1.

1.2 TESTS

.1 Give written 24 hour notice of date for tests.

.2 Do not externally insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.

.3 Conduct tests in presence of Departmental Representative. Arrange for the Owners representative to be present.

.4 Bear costs including retesting and making good.

.5 Refer to Piping Sections for specific test requirements.

.6 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

1.3 BALANCING - LIQUID SYSTEMS

.1 Balance liquid systems using a surface temperature measuring instrument such as Alnor pyrometer or a flow meter if installed. Adjust balance valves and balance fittings to obtain design flow rates or uniform temperature differences (on the liquid side) across coils and heating/cooling elements acknowledging the specified temperature drops and rises on the air and water side.

.2 Permanently mark the final balance position on balance valves and balance fittings and lock memory stops.

.3 Submit a report to the Departmental Representative indicating the final temperatures obtained.

1.4 TESTING AND BALANCING

.1 Employ an approved independent testing and balancing agency to test and balance the following systems. Prior to finalizing contractual arrangements with the balancing agency, submit the names, qualifications and years of direct field testing and balancing experience in the testing and balancing field for all members of the balancing team that is scheduled to carry out the balancing work. The senior site technologist must have a minimum of five years testing and balancing experience of similar projects. Provide a list of a minimum of ten comparable projects successfully completed by all key members of the balancing team.

.1 Heating hot water system(s).

.2 The Agency shall be responsible to the Contractor but report jointly to the Departmental Representative and the Contractor. Report in writing to the Departmental Representative any lack of cooperation and any discrepancies or items not installed in accordance with the contract documents.

.3 Procedures shall be in general accordance with AABC'S National Standards for Field Measurement and Instrumentation and ASHRAE Standards.

.4 The balancing agency shall agree to perform spot checks, where requested, in the presence of the Departmental Representative's designated representative.

.5 Work with the agency to:

.1 Ensure that all mechanical systems are complete and ready to be balanced and provide sufficient time for testing and balancing prior to substantial performance.

.2 Make corrections to achieve system balance without delay, include all corrections made during the balancing procedure on "As Built" Drawings. Mechanical Contractor to provide "As Built" information to the balancing agency before balancing commences.

.3 Adjust fan drives, change blade pitch angles and change sheaves and belts as directed by the agency.

.4 Maintain all systems in full operation during the complete testing and balancing period.

.5 Employ control technicians to make adjustments to the control systems to facilitate the balancing process.

.6 Employ the journeyman millwright to check the alignment of any V-belt drives and/or shaft coupling drives if they have been adjusted during the balancing process. Belt tension correctness to be verified.

.6 Consult with the Departmental Representative to clarify the design intent where necessary or in case there are any problems foreseen as the balancing processes.

.7 Instrument calibration: At the Departmental Representatives request, the balancing agency shall submit a dated calibration chart for all instruments.

.8 Permanently mark final settings on valves, dampers and other adjustment devices. Set and lock all memory stop balancing devices.

.9 Seal all holes with snap plugs or approved alternate method, used for flow and pressure measurements.

.10 The controls contractor and balancing agency are to allow for checking and making adjustments during the 12 month warranty period, when weather conditions provide natural loads and in cases where complaints arise.

.11 Submit a draft balance report to the Departmental Representative for approval and submit approved copies to the agency preparing the O & M manuals for inclusion in each operating and maintenance manual. Provide field notes in the balancing report to clearly identify unusual conditions, problem areas and report on any cases where the specified flow rates or conditions could not be achieved by adjustment. Identify outstanding problems that cannot be corrected by the balancing team or that will not be corrected by the installing trades (e.g. in cases where additional balancing dampers are required).

.12 Submit a statutory declaration to the Departmental Representative, certifying that the testing and balancing procedures have been completed, that complete factual reports have been distributed and that directions have been given to the Contractor to correct faults and omissions and, finally, that follow-up testing, after correction of faults and omissions, has been completed and recorded. Form MF170 in Section 23 06 02 should

be used for this purpose. Reports to be signed by the senior member of the balancing team.

.13 Employ the testing and balancing agency to test all fire dampers as follows:

.1 Test all fire dampers. The test shall be made by releasing the fusible link and witnessing closure of the damper. All fire dampers shall be left in the open position.

.2 A set of prints shall be marked up to show that each damper has checked for closure, accessibility and installation or provide schematic mechanical drawing showing all fire damper locations, label all fire dampers on drawing and reference to form MF172. The prints shall be certified correct by the agency and submitted to the Departmental Representative with completed test certificate MF172.

1.5 LIQUID SYSTEMS - BALANCING

.1 Set balance valves and balance fittings to provide required or design flow rates for each system component.

.2 Use installed flow measuring devices to determine flow rates for system balance. Where flow measuring devices are not installed, base flow balance on the air and liquid temperature difference across terminal heating/cooling elements and coils, acknowledging the different design temperature drops/rises used in the design of the systems.

.3 Effect system balance with automatic control valves fully open to heat transfer elements.

.4 Trim pump impellors to match pump performance to system characteristics rather than artificially increasing system pressure drops to match pump characteristics.

.5 Check air vents to ensure that they are correctly installed and are operating properly. The mechanical contractor shall ensure that all air is removed from within the piping system and that there is flow throughout all piping systems before the balancing is started.

.6 Include in the liquid balance report:

.1 Date of test, Name and address of building and balancing technician's name.

.2 Range of outdoor air temperature during the balancing procedure.

.3 Pumps: Tag, service, location, manufacturer, model and size. Specified and actual flow and head pressure. Motor size, speed, amps and voltage.

.4 Flow measuring devices: Flow rates.

.5 Terminal heating elements: Entering and leaving liquid temperatures.

.6 System schematics: Specified and actual flow rates.

.7 Provide pump performance curve for each new pump system.

1.6 COMMISSIONING AND DEMONSTRATION

.1 Refer to Division 1 (Section 01 91 13) for additional general requirements to those listed below. Division 1 requirements are to supersede any of the requirements listed below in case of requirements discrepancy.

.2 Be responsible for the performance and commissioning of all equipment supplied under Division 23. Commissioning is the process of advancing the installation from the stage of static completion to full working order in accordance with the contract documents and design intent. It is the activation of the completed installation.

.3 Provide the services of an approved independent specialist firm to coordinate the commissioning process specified under this division.

.4 The commissioning shall be executed in accordance with the intent of ASHRAE Standard 1-2013 "Guideline for Commissioning of HVAC Systems" and Standard 0-2013 "Total Building Commissioning".

.5 In consultation with the General Contractor, ensure that sufficient time is allowed and fully identified on the construction schedule for the proper commissioning of all mechanical systems.

.6 The cooperation of all trades is essential for an efficient and planned process. A team comprising the following is recommended:

.1 Commissioning Coordinator.

.2 General Contractor.

.3 Mechanical Contractor's Supervisor.

.4 Building Owner's representative.

.5 Division 23 Trades: especially Controls Contractor & Balancing Agency.

.7 Prepare a commissioning statement for each of the four [4] phases that the process is perceived to be worked through. In sequence, the phases are expected to be:

.1 PHASE 1 - System readiness.

.2 PHASE 2 - System start-up, testing, balancing etc.

.3 PHASE 3 - Verification of system performance.

.4 PHASE 4 - Demonstration & instruction.

.8 Each phase is applicable to each major and/or separate system making up the work in Division 23 plus Division 26 interface as applicable.

.9 Regular meetings shall be held during the commissioning process. Minutes of the meetings shall be issued to all contractors involved, the Departmental Representative and the Owners representative.

.10 Plan the work to be specific in respect of personnel, schedule, review and laboratory tests.

.1 Personnel: Assign direct overall charge of commissioning to a person (the commissioning coordinator) fully qualified through practical experience and a comprehensive knowledge of the interactive nature of building systems and their controls to understand the complete system and be available to carry the project through to total completion. This person shall be responsible for: Commissioning, Demonstration to the Departmental Representative and Owner and Certifications of Substantial and Total Performance.

.2 Schedule: Submit a schedule, as part of the construction schedules, for the commissioning phase of the work. This schedule shall show:

.1 Equipment start-up schedule.

.2 Submission dates for the various documents required prior to substantial performance.

.3 Timing of the various phases of the commissioning, testing, balancing and demonstration process.

.3 Review: Within three [3] months of commencing with the project work, the person having direct overall charge of commissioning shall review design intent and intended commissioning procedures with the Departmental Representative. Six [6] months prior to the date of scheduled substantial performance, submit a detailed plan that addresses the entire approach to the commissioning process. The plan should be prepared specifically for the project at hand. The plan should include the following components:

.1 Name and qualifications of the commissioning coordinator.

.2 Itemized check lists for the readiness, start-up and operational verification of all equipment and systems.

.3 Outline of proposed method of notification and correction of interim operational deficiencies.

.4 Outline of proposed demonstration and operator training program.

.4 Laboratory Tests: If the field tests indicate that equipment supplied to the project does not meet specifications, laboratory certification of the potentially deficient equipment may be requested [by the Departmental Representative]. In the event that equipment does not meet specifications, be responsible for the costs of:

.1 The above laboratory tests, and

.2 All subsequent testing and correction required.

.11 The work included in each of the four phases shall be generally as follows:

.1 PHASE 1 System readiness

.1 Before starting any of the separate systems, provide a certificate stating that the specific system is ready for start-up and the following conditions have been met. (See also Section 23 06 02).

.1 All safety controls installed and fully operational (dry run test).

.2 Qualified personnel available to operate the plant.

.3 Permanent electrical connections made to all equipment.

.2 System readiness shall include, but not necessarily be limited to the following:

.1 Checking system physical completion, including all instrumentation.

.2 Flushing, chemical cleaning (as required), charging, fluid treating (as required).

.3 Equipment lubrication and prestart checks.

.4 Rotational checks.

.5 Filter systems installed and sealed in place.

.6 Adjusting vibration isolation and seismic restraints.

.7 Alignment of drives (direct and belt).

.8 Control function checks, including all alarms.

.9 Self-diagnostic packaged control items checked.

.10 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently, corrected before proceeding to PHASE 2.

.2 PHASE 2 System startup, testing, balancing

.1 System commissioning shall include, but not necessarily be limited to:

.1 Activation of all equipment and systems.

.2 Testing and adjustment of all equipment and systems.

.3 All deficiencies are to be recorded, reviewed by the commissioning team and, subsequently, corrected. The process at the point of the deficiency, shall be repeated before proceeding to PHASE 3.

.2 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:

.1 Balancing of the liquid systems as specified in this section.

.2 Set up all automatic control valves/dampers and automatic temperature control devices.

.3 Adjust air valves as necessary.

.4 Plug all air pressure and flow measuring holes.

.5 Adjust vibration isolators and earthquake restraints as necessary.

.6 Verification and certification of the sealing of all HVAC penetrations through fire separations (rated & non-rated) and sound separations.

.7 Verification of water tightness of all roof and exterior wall penetrations.

.8 Testing and debugging of B.A.S. (Building Automation System).

.9 Set up and test all alarm protective devices.

.10 Calibration and adjustment of the smoke venting.

.11 Power failure test with emergency generator start-up.

.3 Fine Tuning

.1 Setting up automatic controls for accurate response and precise sequencing.

.2 Correction of problems revealed by Balance Agency and change of fan speed and pitch as necessary.

.4 Testing

.1 A detailed check by a person having direct overall charge of commissioning. This check to include all items and functions to be later demonstrated to the Departmental Representative and Owner's representatives.

.3 PHASE 3 Verification of System Performance

.1 Verification of system performance by the Departmental Representative will not commence until PHASE 2 has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 The ease of access that has been provided throughout for servicing coils, motors, drives, fusible fire damper links, control dampers and damper operators.

.2 Location of and opening and closing of all access panels.

.3 Operation of all automatic control dampers and automatic temperature control devices.

.4 Proper response of all variable volume air valves to thermostats and volume adjustment controls.

.5 Operability of randomly selected fire dampers.

.6 Noise level from typical variable volume air valves under extreme operating conditions.

.7 Operation of all equipment and systems, under each mode of operation including:

.8 B.A.S. control features.

.9 Automatic controls.

.10 Pumps.

.11 Cabinet unit heaters.

.12 Unit heaters.

.13 Boilers and associated gas/ fuel systems.

.2 At the completion of Phase 3, the Contractor shall submit the following to the Departmental Representative:

.1 A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.

.2 A commissioning report which should include completed copies of all Phase 2 documentation outlined in the commissioning plan plus copies of start-up reports from specialty contractors and vendors and any other relevant information for inclusion in the operating & maintenance manuals.

.3 B.C. Boiler Inspection Dept. approval of boiler, pressure vessels and pressure piping installations.

.4 B.C. Gas Inspection Dept. approval of boiler on gas firing.

.5 Record drawings as specified, update to include changes resulting from commissioning.

.6 A statement confirming completion of B.A.S. acceptance test, Section 23 09 01.

.4 PHASE 4 Demonstration and Acceptance

.1 Demonstration and acceptance shall not commence until the commissioning process PHASE 3 has been successfully completed.

.2 The Demonstration process is a planned process requiring a preplan approval before commencement and a signed statement of satisfaction from the Owner upon completion.

.3 For Demonstration and instruction to Operating staff requirements, refer to this section of the specification and also to section 23 09 01 (Controls Systems).

.4 Systems operation in the fire mode shall be demonstrated to the Authorities having jurisdiction. Obtain a written statement/certificate of approval.

.5 Post Substantial Performance Visits

.1 Provide follow-up visits to the site at one month and six month after substantial performance for a minimum period of two days, to ensure that the systems are operating correctly and that they are being operated and maintained properly.

.2 Submit a report to the Departmental Representative and Owner which documents any problems that have arisen and correction action required.

1.7 OPERATING AND MAINTENANCE MANUALS

.1 Refer to Division 1 (Section 01 78 00, clause 1.3 "Interactive Operating and Maintenance Manual System") for additional or more stringent requirements to those listed below.

.2 Employ an approved independent contractor specializing in operating and maintenance manuals to prepare instruction manuals covering the operation and maintenance of the mechanical systems and equipment installed under this contract.

.3 Request the manufacturers' brochures at the time of equipment purchase. Forward all necessary data including approved shop drawings and manufacturers brochures to the Agency for inclusion in the Manual.

.4 Instructions shall be clearly written in language easily understood by the Operating and Maintenance personnel. Include only specific information pertinent to the equipment installed. Advertising literature and brochures of a general nature will be rejected.

.5 A front title page shall identify the Project, the Owner, the Architect and the Mechanical Consultant. In addition the names of the General Contractor, Mechanical, Sheet Metal, and Control with addresses and telephone numbers shall be listed.

.6 An index shall be provided and the manual shall be divided by index dividers including but not limited to the following major sections:

.1 Systems Description

.1 Comprehensive description of the operation of each system including the function of each item of equipment within the systems and all reset schedules and seasonal adjustments.

.2 Include a schematic drawing and component description for each major mechanical system including air handling systems, boiler and hot water heating piping distribution systems.

.3 The schematic drawing shall identify each component with a letter designation corresponding to a description briefly explaining the purpose of each component and how it relates to the other components, and be presented in a current version of AutoCAD or similar computer aided drafting program.

.4 Description of actions to be taken in event of equipment failure.

.2 Maintenance and Lubrication

.1 Maintenance schedules including detailed servicing, maintenance and trouble-shooting instructions for each item of equipment including daily, weekly, monthly, semi-annual and annual checks and tasks.

.2 Lubrication schedules, indicating recommended lubricants and grades (grease or oil) for all lubricated equipment components.

.3 Manufacturer's technical literature for each item of equipment installed. Literature shall include: Operating instructions, Maintenance instructions, Wiring Diagrams, Parts list and Installation instructions, Ventilation requirements, Energy considerations, Automatic temperature control settings, Information regarding air filters and pressure drops for clean and dirty conditions., Trouble Shooting Procedure Guide in spreadsheet form with the most likely causes and recommended actions for all foreseeable problems. Trouble Shooting Procedure guides are required for all the major items of equipment including air handling systems, exhaust fans, circulating pumps, mechanical cooling equipment, etc., and Mechanical Equipment Starting Procedures.

.3 Equipment Suppliers

.1 Local source of supply for replacement parts for each item of equipment.

.4 Balancing Reports

.1 Water system balancing report.

.5 Electrical Switchgear

.1 Electrical switchgear schedule, indicating circuit number, panel location and disconnect location for each item of equipment.

.6 Shop Drawings

.1 Copies of all "reviewed" shop drawings including fan and pump performance data including performance curves with the operating point indicated. Shop drawings shall be c/w Departmental Representatives review form.

.2 Plumbing fixture brochure.

.3 In addition to the shop drawings provided for the various items of mechanical equipment, this section shall also include the Manufacturers' Literature on:

.1 Operating and maintenance instructions

.2 Spare parts lists

.3 Troubleshooting information.

.7 Schedules

.1 Labelling and identification schedules including colour coding.

.2 Valve schedule, including location, service, normal position and area served.

.3 Air filter schedule indicating model no, size, number of filters required and servicing instructions (i.e.) static pressure readings, etc. for each filter bank.

.8 Guarantees, Certificates And Miscellaneous Reports

.1 Boiler Inspection - Certificate of Approval.

.2 Checklists for start-up (MF151, 152,153).

.3 Certificate of Testing and Balancing (MF170).

.4 Certificate of Penetrations through separations (MF173).

.5 Certificate of Seismic Restraint Installation (MF174).

.6 Certificate of Vibration Isolation Installation (MF175).

.7 Checklists for Demonstrations (MF181, 182, 183).

.8 Certificate of Substantial Performance (MF190).

.9 Chemical cleaning and treatment report for piping systems.

.10 Commissioning reports/checklists.

.11 Equipment performance test results.

.12 Extended warranty certificates.

.13 Gas Inspection - Certificate of inspection.

.9 Control Systems

.1 Descriptive sequence of operation of automatic control system, with "as-built" control schematics indicating the final settings.

.2 Control equipment maintenance bulletins.

.3 Interlock wiring diagrams.

.4 Refer to section 23 09 24 for Building Automation System manual requirements.

.7 Submit a draft copy of the Manual to the Departmental Representative for approval, thirty [30] days prior to start-up of the systems and equipment.

.8 After receiving approval of the draft copy, make any corrections as may be required and then furnish three [3] final copies to the Departmental Representative at least ten [10] days prior to the substantial performance inspection date. Provide more than one volume if the overall thickness of a single binder would exceed 100 mm [4"].

.9 Printed hard cover manuals shall be supplied in 3 post hard back Acco expansion style "Fliplock" binders, with stamped lettering on the front cover and spine showing the following:

.1 Name of Project

.2 Name of Manual - "Operating and Maintenance Manual Mechanical Systems"

.3 Volume- "X" of "Y"

.10 Digital manuals shall be supplied on three (3) CD-ROMs in digital format. The information shall be organized into sections in a user-friendly format that is easy to search for specific information. An indexing system shall be included that remains on an expandable portion of the screen and allows the end user to scroll through the manual information that appears on the main portion of the screen. The digital version content and organization for each manual shall be arranged in a manner identical to the hard copy version. The specific requirements are listed below:

.1 Utilize Adobe Acrobat 5.0 (or later) Portable Document Format (PDF).

.2 If there is more than one volume of manual, indicate “Volume X of Y” for each volume.

.3 Include a copy of Adobe Acrobat Reader 5 (or later)

.4 The final Digital copies are to be copied to CD media with a custom CD label.

.5 The custom CD label shall include: Project Name, Location of Project, Date of Assembly, name of Mechanical Consultant, and shall be titled “Operating & Maintenance Manual for Mechanical Systems”.

.6 The Digital Manual shall be enhanced with the following features: Bookmarks, Internet Links, Internal Document Links and Optical Character Recognition (OCR). Refer to Scanning Requirements and Organizational Requirements listed below.

.7 Scanning Requirements:

.1 All pages contained within the hard copy manual are to be scanned and/or digitized to Adobe Acrobat 5.0 (or later) PDF.

.2 Provide a minimum 300 DPI for all scanned pages.

.3 All scanned material may be searched for text with minimum 60% Optical Character Recognition (OCR).

.4 All scanned shop drawings are to be scanned to a minimum 8.5"X11" size. If the original page size is 11"X17", the digital copy shall also be 11"X17".

.5 Rotation of scanned page images/texts shall be displayed within +/- 20 degrees.

.8 Organizational Requirements:

.1 Digital Manual shall be organized in the same manner as the approved Hard Copy Manual. (e.g. Tabs 1.1, 1.2, 1.3, 2.0, 3.0, etc)

.2 Bookmark all major tabs and subsections

.3 Bookmark each set of shop drawings

.4 Link the Table of Contents page to the referenced sections

.5 Insert an introduction / summary page for all sections indicating major subsections. Link these pages to their referenced sections

.6 Link the system descriptions to the referenced schematic drawings.

.7 Insert internet links and internal document links to mechanical equipment manufacturers / suppliers / contractors official websites; and to mechanical equipment shop drawings.

.8 Use the following colour code for links: internet links shall be light blue with underline, internal document links shall be dark blue (excludes AutoCAD schematic links), and links to other PDF files shall be dark green.

.9 It is the responsibility of the mechanical contractor to provide high quality documentation for scanning.

.10 The digital version of the manuals and the hard cover version shall be prepared by the same company.

.11 Digital Manual shall be reviewed by the Departmental Representative for content and layout prior to final submission.

.12 All information within the hard copy manual shall be included within the Digital Manual. At the Owner's / Departmental Representative's discretion the following exceptions may be made so that the manual may be available for use by the Owner at an earlier date:

.1 The final Balance Report may be provided as a later submission in Adobe Acrobat 5.0 (or later) Portable Document Format (PDF). In this case, Balance Report(s) may be kept separate from the Digital Manual.

.2 The final Commissioning Report may be provided as a later submission in Adobe Acrobat 5.0 (or later) Portable Document Format (PDF). In this case, the Commissioning Report(s) may be kept separate from the Digital Manual.

.11 Manuals shall be supplied in 3 post Acco expansion style "Fliplock" binders, with clear window label insert on front cover and indicating Name of Project and Name of Manual.

1.8 MAINTENANCE PROGRAM

.1 Employ the agency, which is preparing the operating and maintenance manuals, to prepare maintenance schedules suitable for inputting into the existing computerized maintenance program. Obtain from the owner the format in which the schedules should be prepared.

.2 Maintenance Schedules:

.1 The maintenance schedules shall detail preventative maintenance procedures and their required frequency (daily, weekly, monthly, quarterly, half yearly, yearly and seasonally) for each system.

.2 Major items of equipment, such as boilers, etc. shall be listed on individual schedules.

.3 Equipment Maintenance Record Cards

.1 A record card shall be prepared for each piece of equipment stating its identifying name, unit number, manufacturer, model number, local supplier, serial number and all data relative to its operation and maintenance.

.4 After substantial performance has been declared, the agency shall visit the facility to explain and instruct the representative designated by the Owner on the use of the maintenance program.

1.9 RECORD DRAWINGS

.1 Refer to Division 1 (Section 01 78 00, clause 1.6 "As Constructed drawings and samples") for additional requirements to those listed below. Maintain one set of contract drawing white prints, including all supplementary and revision drawings on site, solely for the purpose of recording, in red, any change and/or deviation from the Contract Drawings as it occurs. Include elevations and detailed locations of buried services.

.2 The set of white prints will be provided to the contractor by the Departmental Representative at the contractors cost.

.3 The marked-up set of prints shall be reviewed on site monthly by the Departmental Representative during the construction process. This review will form a requirement for approval of the monthly progress claim.

.4 Back filling shall not occur until underground services dimensions are marked on the prints,

.5 The Record Drawings shall include, but not limited to, the following changes and shall be recorded daily:

.1 Size, location, arrangement, routing and extent of piping, equipment, clean-outs, valves, rough-in, etc. above and below grade inside the building and including dimensioned locations of buried piping from building walls

.2 Location of all heat traced piping and associated controllers.

.3 Location of back flow preventers.

.4 Location of water hammer arrestors.

.5 Water lines: Invert elevations to be recorded at each junction, changes of direction and every 30 m [100 ft] run.

.6 Gas Lines: Invert elevations to be recorded at each junction, at building entry point and at changes of direction.

.7 All services located below ground level and in or below a building slab.

.8 All valve stations, trap stations, coils dampers and ductwork not easily accessible.

.9 Location, tagging and numbering of all valves as specified in Section 23 05 53.

.6 CAD Drafting:

.1 Purchase a set of CAD files from the Consultant. Allow a cost of $400.00 per each drawing. Obtain the services of the Consultant or an approved CAD draftsperson to transfer all changes to amend the CAD files in the latest version of AutoCAD.

.2 Include all details from revision drawings, addenda, and change orders. Label each drawing in the lower right corner in letters of at least 12mm [1/2"] high as follows:

.1 "AS BUILT DRAWINGS", Contractors name and date.

.3 Provide one set of check prints for review by Departmental Representative.

.4 Upon acceptance by the Departmental Representative, provide computer CAD files and one set of plots [0.03 mm mylar sepias plots].

.5 Note: The Contractor will be required to sign a standard Stantec Consulting Ltd. / Contractor agreement entitled "Authorization to Use CAD drawing files". The agreement restricts the use of the CAD files to the purpose of "as-built" only and determines the editing procedures.

1.10 DEMONSTRATION AND INSTRUCTION TO OPERATING STAFF

.1 Provide certified personnel to demonstrate plant operation and to instruct operating staff on operation of mechanical equipment. Provide maintenance specialist personnel to instruct operating staff on maintenance and adjustment of mechanical equipment and any changes or modification in equipment made under terms of guarantee.

.2 The demonstration shall include:

.1 Operation and sequencing of all automatic control dampers and automatic temperature control devices.

.2 Operability of randomly selected fire dampers.

.3 Operation and maintenance requirements of all equipment and systems under each mode of operation including, but not limited to:

.1 Automatic controls.

.2 Hot water heating system.

.3 Coils.

.4 Pumps.

.5 Other mechanical equipment and system

.3 Provide instruction during regular work hours prior to acceptance and turn-over to operating staff for regular operation.

.4 Use Operating and Maintenance manuals for instruction purposes.

.5 Submit the proposed instructional agenda for approval.

.6 Finalize demonstration and instructions by obtaining a signed statement from the Owner that the demonstration and instructions have been given satisfactorily. Forms in Section 23 06 02 should be used for this purpose.

1.11 SUBSTANTIAL PERFORMANCE REQUIREMENTS

.1 Before the Engineer is requested to make an inspection for substantial performance of the work:

.1 Commission all systems and prove out all components, interlocks and safety devices.

.2 Submit a letter certifying that all work (including calibration of instruments and balancing of systems) is complete, operational, clean and all required submissions have been completed. Form MF190 in Section 23 06 02 should be used for this purpose.

.2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:

.1 All reported deficiencies have been corrected.

.2 Testing and balancing completed.

.3 Operating and Maintenance Manuals completed.

.4 "As Built" Record Drawing ready for review.

.5 System Commissioning has been completed and has been verified by Engineer.

.6 All demonstrations to the owner have been completed.

.7 All documents required on Form MF188, Section 23 06 02 have been submitted.

.3 Letters of assurance will not be issued until the following requirements have been met:

.1 All items listed in .1 and .2 above have been completed.

.2 Gas Inspection - Certificate of inspection.

.3 Seismic Engineers letter of Assurance and final inspection report.

.4 Certificate of Substantial Performance (MF190).

.5 Signed off copy of final inspection report.

1.12 DEFICIENCY HOLDBACKS AND DEFICIENCY INSPECTIONS

.1 Work under this Division which is still outstanding when substantial performance is certified will be considered deficient and a sum equal to at least twice the estimated cost of completing that work will be held back.

.2 It is expected that outstanding work will be completed in an expeditious manner and the entire holdback sum will be retained until the requirements for Total Performance of Division 23 work have been met and verified.

END OF SECTION

Part 1 Mechanical Forms

1.1 MF 100 Check List – Submissions to Departmental Representative

ITEM	CHECKED BY	DATE
10 WORKING DAYS BEFORE CLOSE OF SUBTRADE TENDER – Request for addition of acceptable manufacturers		
10 DAYS AFTER AWARD OF THE CONTRACT – List of equipment suppliers and subtrades – Detailed price breakdown (MF 120, 121, 122)		
A.S.A.P. – Product & Fabrication samples (MF 131) – Shop Drawings		
WITH EACH APPLICATION FOR PROGRESS PAYMENT – Price breakdown (MF 120, 121, 122)		
PRIOR TO CLOSING IN CEILINGS & SHAFTS – Duct and pipe test data		
PRIOR TO STARTING SYSTEMS – Checklists for start-up (MF 151, 152, 153)		
PRIOR TO COMMISSIONING SYSTEMS – Checklists for operation (MF 151, 152, 153) – Commissioning schedule		
PRIOR TO DEMONSTRATION OF SYSTEMS – Demonstration agenda		
10 DAYS PRIOR TO SUBSTANTIAL PERFORMANCE INSPECTION – Submission of items listed on Form MF-188		
WHEN REQUESTING INSPECTION OF OUTSTANDING WORK – Certificate of total completion (MF 192) – Checklist of work remaining (MF 191) – Checklists of Demonstrations (MF 181, 182, 183)		

1.2 MF 152 Check List - Start-up and Operation Requirements – Water Systems

System: _____

ITEM	CHECKED BY	DATE
Prior To Start-Up Safety Controls Installed & Operational Permanent Electrical Connections Made Equipment Lubricated System Flushed Out Operating & Maintenance Data Available Boiler Inspector Notified Chemical Treatment Agency Notified		
During Start-Up Qualified Operator In Charge Rooftop units Manufacturer's Rep. present		
Prior to Operation Boiler inspectors Approval Obtained Report from Chemical Treatment Agency Submitted		
During Operation Qualified Operator In Charge Equipment Maintained Lubrication Maintained & Logged Chemical Treatment Maintained And Logged		

NOTES:

.1 This is a brief check list and does not cover all procedures which may be advisable in a particular case. Additional information is available from equipment suppliers.

.2 Prior to starting or operating each system complete the appropriate section of this form and submit it to the Departmental Representative.

.3 Submit completed copies of this form for each system with the certificate of substantial performance.

1.3 MF 170 Certificate of Testing and Balancing

I hereby declare that I _____

I am an employee/a principal of _____

And certify that the testing and balancing procedures specified under division 15 have been satisfactorily completed and I hereby certify that complete factual reports have been distributed.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be submitted when requesting inspection of substantial performance.

1.4 MF 174 Certificate of Seismic Restraint Installation

I hereby declare that I _____ am an employee/a principal of _____

And certify that the seismic restraint of all mechanical equipment, piping and ductwork specified under Division 15 has been satisfactorily completed and that the installation meets the requirements of the B.C. Building Code as it relates to seismic restraint.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be submitted when requesting inspection of substantial performance.

1.5 MF 175 Certificate of Vibration Isolation

I hereby declare that I _____ am an employee/a principal of _____

And certify that the vibration isolation installation specified under Division-15 has been satisfactorily completed.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be submitted when requesting inspection of substantial performance.

1.6 MF 180 Check List & Record – Items to be Handed to Owner

ITEM	RECEIVED	DATE
Chemical Test Kit		
Control Drawings (Framed/Plasticized)		
Filters - Spare Sets (Panel and Final)		
Hydrometer & Specific Gravity Chart		
Identification Schedule (Framed)		
Maintenance Program (Schedules & Cards)		
Master Key For B.A.S. Field Panels		
Rated Access Door Keys		
Spare Chemicals		
Test Thermometer		
Thermostat Keys		
Valve List (Framed)		
Differential Pressure Meter for Circuit Setting Balance Valves		
P/T Plug Master Test Kit		

NOTES:

.1 Copies of this form to be submitted to the Departmental Representative and the owner with all items signed off when requesting inspection of substantial performance.

1.7 MF 182 Check List – Demonstration of Water System

System: _____

	CONTRACTOR		OWNER	
ITEM	**SIGNED**	**DATE**	**SIGNED**	**DATE**
Review of System Concept				
Review of Maintenance Manual				
Review of System Balance				
Review of Chemical Treatment				
Troubleshooting				
Points of required Maintenance				
Access to Equipment				
Location of Control Devices				
All Electric Interlocks				
All Alarms				
Temperature Control				
Pressure Control				
Volume Control				

NOTES:

.1 Contractor to submit copies of this form with each appropriate item signed and dated by the person having overall charge of commissioning when requesting inspection for substantial performance. (See MF 190).

.2 Owners representative to sign off each item during the demonstration.

.3 Contractor to strike out items where they do not apply to the systems being demonstrated.

.4 Interlocks and controls to be demonstrated by following the descriptions and diagrams in the contract documents and proving that all controls function as required.

.5 Where multiple identical controls are installed (thermostats) the owners representative may elect to only witness sample items, but the person having charge of commissioning is expected to have checked all of them.

1.8 MF 188 Check List – Substantial Completion Submissions - HVAC

SECTION	ITEM	CHECKED
23 05 00	Boiler Inspection Certificate	
23 05 00	Gas Inspection Certificate	
23 05 00	Equipment Extended Warranties Certificates	
23 05 00	Equipment Inventory Sheets	
23 05 00	Lubrication of Equipment Checklist	
23 05 93	Liquid Balancing Report	
23 05 93	Testing & Balancing Certificate (MF 170)	
23 05 93	Commissioning Report and Checklists	
23 05 93	Operating & Maintenance Manuals	
23 05 93	Record Drawings	
23 05 93	Maintenance Program	
23 05 93	Demonstration to Operating Staff agenda	
23 05 53	Identification Schedules	
23 05 48	Vibration Isolation Installation Certificate. (MF-175)	
23 05 49	Seismic Restraint Installation Certificate. (MF-174)	
23 25 00	Chemical Treatment and Cleaning Report for Piping Systems	
23 52 00	Boiler Start-up Test Reports	
23 06 02	Demonstrations Checklists (MF 181, 182, 183)	
23 06 02	Items handed to Owner Checklist (MF 180)	
23 06 02	Substantial Performance Certificate (MF(190)	
23 06 02	Checklist of work remaining after Substantial (MF 191).	

NOTES:

.1 This list is provided as a checklist and may not include all substantial completion requirements.

1.9 MF 190 Certificate of Substantial Performance Division 15

I hereby certify that I _____ am an employee / a principal /an agent

of _____

and have personally witnessed the following with regard to the mechanical systems work specified on the above project and that to the best of my knowledge except as noted on MF 191 (attached);

- The installation is complete and as specified.
- The systems have been commissioned and operate satisfactorily.
- Every control sequence and every control performs as specified.
- The systems are clean.
- All of the required submissions have been made to the Departmental Representative.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be completed and submitted to the Departmental Representative when requesting inspection for substantial performance.

.2 If it is apparent during this inspection that the systems or their operation are seriously deficient then all reasonable costs of any subsequent inspections shall be deducted from the contract sum.

1.10 MF 191 Check List – Work Remaining After Substantial Performance

		COMPLETION		
ITEM NO.	**DESCRIPTION**	**CLAIMED BY**	**DATE**	**VERIFIED DATE**

NOTES:

.1 This form must be filled in and submitted to the Departmental Representative when requesting inspection for substantial performance.

.2 Items arising out of this inspection will be added to the list by the Departmental Representative. Copies of the complete list will be circulated to the Owner, the Architect and the Contractor.

.3 The Contractor may include estimated values against the outstanding work but determination of the actual amounts to be held will be made by the Departmental Representative.

.4 The Contractor shall sign off each item as it is completed and submit the list monthly to the Departmental Representative. When all items are signed off the completed list shall be submitted with the certificate of total performance MF 192.

1.11 MF 192 Certificate of Total Performance – Division 15

I hereby certify that I _____ am an employee / a principal / an agent

of _____

and have personally witnessed that each item of outstanding work on the checklist and record of work remaining after substantial completion MF 191 (attached) has been satisfactorily completed and I hereby certify that the
Mechanical systems work specified on the above project is complete.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be completed and submitted to the Departmental Representative when requesting inspection for total performance.

.2 If it is apparent during this inspection that the systems or their operation are seriously deficient then all reasonable costs of any subsequent inspections shall be deducted from the contract sum.

End of Section

ITEM	ACCEPTABLE PRODUCTS / SUPPLIERS / MANUFACTURERS	SHOP DWG.
ACCESS DOORS		
Building Surfaces	Acudor, Cendrex, E.H. Price, Maxam, Milcor, Mifab, Steel Brothers	-
ACCESS PANELS		
Ducts	Nailor, Ventlok	-
BOILERS		
High Efficiency, Condensing	Aerco, IBC Technologies, Teledyne-Laars, Viessmann, RBI	X
CHIMNEYS		
Boilers (Positive Pressure)	Ampco, Cleaver Brooks, Metalbestos PS, IPS, Van-Packer DW, Metal-Fab PIC	X
EXPANSION JOINTS	Flexonics, Hyspan, Uniroyal, Keflex, Mason, Goodall, Victaulic,	
GAS VENTS	Ampco, Ecco, Selkirk Metalbestos	X
GAUGES – AIR PRESSURE	Dwyer 2000	X
GROOVED JOINT COUPLINGS & FITTINGS	Victaulic	X
HEATERS		
Baseboard (electric)	Chromalox, Chaudair, Ouellet	X
Convector (Liquid / Steam)	Eng. Air, Rosemex, Trane, Sterling	X
Wall Fin	Eng. Air, Rosemex, Slant / Fin, Trane, Sterling	X
INSULATION - PIPING	Fiberglas, Knauf, Johns-Manville, Manson, Atlas, PPG, Certainteed	
PIPE CONNECTORS (FLEXIBLE)	Mason Victaulic(flexible couplings)	X
PRESSURE REDUCING VALVES		
Water	Cashco, Watts,	X

ITEM	ACCEPTABLE PRODUCTS / SUPPLIERS / MANUFACTURERS	SHOP DWG.
PRESSURE RELIEF VALVES		
Water (Bypass)	Braukmann, Fulflo, Lonergan	X
Water	Cashco, Watts	X
PUMPS		
Condensate Transfer	Grundfos, Darling, Skidmore, Bell & Gossett	X
Pipe Mounted	Armstrong, Bell & Gossett, Grundfos, Taco	X
Vertical In – Line	Aurora, Armstrong, Bell & Gossett, Grundfos, Leitch, Paco, Taco	X
SEISMIC ISOLATORS	Mason, USS Snubbers	X
VARIABLE SPEED MOTOR DRIVE	ABB, Allen-Bradley, Baldor, Hitachi, Graham, Siemens, Teco- Westinghouse, Toshiba	X
VIBRATION ISOLATORS	Mason, Korfund	X

NOTE:

.1 The design is based upon the equipment listed in the equipment schedules and/or underlined in the H.V.A.C. Equipment Supplier Schedules.

.2 **X** Denotes required submission.

END OF SECTION

BALANCING:	K.D. ENGINEERING CO.
	WESTERN MECHANICAL SERVICES
	MDT SYSTEMS LTD.
	INLAND TECHNICAL SERVICES LTD.
COMMISSIONING:	K.D. ENGINEERING CO.
	INLAND TECHNICAL SERVICES LTD.
	AIRMEC SYSTEMS LTD.
	WESTERN MECHANICAL SERVICES
OPERATING & MAINTENANCE MANUALS:	
	K.D. ENGINEERING
	WESTERN MECHANICAL SERVICES
	MDT SYSTEMS LTD.
	INLAND TECHNICAL SERVICES
CLEANING AGENCIES:	
- **DUCTWORK**	POWER SUCTION SERVICES LTD.
	ACE MOBILE POWER SERVICES LTD.
	CLEAN AIR SERVICES CANADA LTD.
- **WATER PIPING**	BIRD ARCHER
	GRACE DEARBORN
	IPAC CHEMICALS
	PACE CHEMICALS
	SAVOLITE
CONTROLS:	RELIABLE CONTROLS (Control Solutions Only)

CHEMICAL TREATMENT:	BIRD ARCHER
	GRACE DEARBORN INC.
	IPAC CHEMICALS
	PACE CHEMICALS
	SAVOLITE

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 GENERAL

.1 Provide thermal insulation on all piping, valves and fittings, as called for and as scheduled. Note items listed that do not require insulation.

.2 Journeyman insulation applicators, skilled in this trade, shall perform the work.

.3 Be responsible for ensuring that sufficient space is always provided to allow proper installation of insulation materials.

.4 As applicable, use the latest edition of the "B.C. Insulation Contractors Association (BCICA) Quality Standards Manual", as a reference standard if sufficient detail/information is not contained herein.

1.3 REGULATORY REQUIREMENTS

.1 Flame spread ratings and smoke developed classifications shall be as required by the National Building Code of Canada 2015 and NFPA 90A. Generally, the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50.

.2 Insulation thickness and insulating values shall be in accordance with ASHRAE90.1.

1.4 QUALIFICATIONS AND SAMPLES

.1 Submit, for approval, substantiating manufacturer's documentation (and samples when requested) for all materials, applications and finishing methods to establish that all will satisfy this specification and meet all applicable code requirements, before commencing work.

.2 Submit, for approval, samples of each type of firestopping, smoke seal and accessory.

1.5 DEFINITIONS

.1 "CONCEALED" insulated mechanical services in trenches, chases, furred spaces, shafts and hung ceilings (services in tunnels are not considered to be concealed.)

.2 "EXPOSED" will mean not concealed.

1.6 CONNECTIONS TO EXISTING PIPING (WHERE APPLICABLE)

.1 Make good all existing insulation disturbed or removed to facilitate alterations and additions to existing piping.

Part 2 Products

2.1 PREFORMED PIPE COVERING

.1 Mineral Fibre - Low and Medium Temperature:

.1 With integral vapour barrier jacket and longitudinal lap.

.2 Thermal conductivity at 24°C - 0.033 W/m/deg.C.

.3 Acceptable Products:

.1 Manson Alley K, Owens Corning SSL-11, Knauf 850 ASJ/SSL, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL.

.2 Mineral Fibre - High Temperature:

.1 With integral vapour barrier jacket and longitudinal lap.

.2 Thermal Conductivity at 93°C - 0.040 W/m/deg.C.

.3 Acceptable Products:

.1 Manson Alley Kapt, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL, Roxul ASJ/SL.

.3 Flexible Foamed Elastomeric:

.1 Thermal Conductivity at 24°C - 0.040 W/m/deg.C.

.2 Acceptable Products:

.1 AP Armaflex, Rubatex R-180-FS.

.4 Flexible Closed Cell:

.1 Thermal Conductivity at 24°C - 0.036 W/m/deg.C.

.2 Acceptable Products:

.1 Bondtex Polyethylene, Therma-Cel.

.5 Phenolic closed cell – rigid:

.1 With integral vapour barrier jacket and longitudinal lap.

.2 Thermal conductivity @ 24°C - 0.019 W/m/deg.C.

.3 Acceptable Products:

.1 Kingspan Koolphenk

2.2 FIRE STOPPING AND SMOKE SEAL MATERIALS

.1 References:

.1 CAN4-S115-[M95], Standard Method of Fire Tests of Firestop Systems.

.2 ASTM E814 Standard Method of Fire Tests and Through-Penetration Firestops.

.3 Certifications Listings Intertek Testing Services N.A. Ltd. (Warnock Hersey).

.4 Underwriters Laboratories of Canada. Listing of Equipment and Materials Vol. 3 Fire Resistance Ratings -Revision 4/95.

.2 Submittals:

.1 Submit shop drawings and product data (including MSDS sheets for VOC content).

.2 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.

.3 Submit manufacturers' product data for materials and prefabricated devices. Include assembly/location design system number references with copies of test information.

.4 For building assemblies which do not correspond to any previously tested and rated assemblies, submit proposals based on related designs using accepted fireproofing design criteria.

.3 Materials:

.1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC CAN4-S115 and not to exceed opening sizes for which they are intended.

.2 Service penetration assemblies and design numbers: Certified by ULC in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19. 1997 Certification Listings Intertek Testing Services N.A. Ltd. (Warnock Hersey).

.3 Service penetration firestop components: Certified by ULC in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC or equivalent approved tests by Warnock Hersey.

.4 Fire resistance rating of installed fire stopping assembly shall be not less than the fire resistance rating of surrounding floor and wall assembly.

.5 Acceptable Products:

.1 3M 1000 silicone, Tremco Fyre-Sil, 3M CP25WB, Firestop Systems 4800DW, Nuco Self Seal Fire Stops.

2.3 ACCESSORIES

.1 Insulation Fastenings:

.1 1.6 mm [16 ga.] galvanized wire or 1.6 mm thick copper wire as commercially available.

.2 Jacket Fastenings:

.1 Thermocanvas and All Service:

.1 Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacturer.

.2 Metal Jackets:

.1 Sheet metal screws, pop rivets, bands.

.3 PVC Jacket and Fitting Covers:

.1 PVC self-adhesive tape, plastic pop rivets, bonding cement.

.3 Adhesives:

.1 Flexible elastomeric and flexible closed cell insulation adhesive:

.1 Armstrong 520, Therma-Cel 1590, RubatexR-373, Zipcoat 8A.

.2 Vapour barrier jacket adhesive:

.1 Bakelite 230-39, Childers CP-82, Epolux Cadoprene 400, Foster 85-20.

.3 Fabric adhesive, to insulation pipe covering:

.1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36, Robson White Lag.

.4 Coatings:

.1 Vapour barrier coating on reinforcing membrane or on insulating cement:

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36.

.2 Childers CP-30 (refrigeration suction lines only).

.2 Flexible elastomeric and flexible closed cell insulation finish coating:

.1 Armstrong, Bakelite 120-13, Rubatex, Zipcoat.

.5 Finish Jackets:

.1 Thermocanvas Jacket:

.1 Fattal's Thermocanvas, Robson Flamex FR Canvas or Tai-Can Canvas.

.2 All Service Jacket (with 0.03 mm [0.0019”] minimum thick foil:

.1 Fattal's Fat-Lock ASJ, Fiberglass ASJ, Knauf ASJ, Kingspan ASJ, Manson APT, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ.

.3 PVC Finishing Jacket (minimum 0.50 mm [0.02”] thick:

.1 Proto PVC, Speedline PVC, Zeston PVC.

.4 Aluminum Jacket:

.1 0.51 mm [22 ga.] thick corrugated or smooth aluminum jacketing with longitudinal slip joints and 50 mm [2"] end laps with factory applied protective liner on interior surface.

.1 Childers, Alco Thermoclad 1 or other as commercially available.

.6 Reinforcing Membrane:

.1 Glass reinforcing membrane as commercially available.

.7 Insulating Cement:

.1 Fibrex Superkote, Partek No. 1, Ryder Thermokote MW high temperature.

.8 Finishing Cement:

.1 Ryder Thermokote 1 FW.

.9 Flexible Insulation:

.1 Manson Alley-Wrap, Owens Corning AF 300 Series, Knauf Plain Wrap, Johns Manville Microlite, Roxul Wrap (RW).

.10 Preformed Fitting Covers:

.1 Aluminum Fitting Covers:

.1 0.51 mm [22 ga.] thick, die shaped components with factory applied protective liner on interior surface.

.1 Childers Ell-Jacs, Perma-Ells or Shield-Ells or other as commercially available.

.2 PVC Fitting Covers:

.1 0.50 mm [0.020"] thick premoulded one piece covers.

.1 Certainteed Snapform, Childers, Proto PVC, Speedline PVC, Zeston PVC, Fattal PVC.

.11 Preformed Insulation fittings:

.1 Shur-Fit, Moulded Acoustic Products or from insulation fabricators.

2.4 SCOPE OF INSULATION

.1 Heating Pipe, Fittings and Valves:

.1 Insulate the following systems, unless otherwise noted:

.1 Hot water heating supply and return piping.

.2 Hot gas piping.

.3 Any other hot water piping.

.2 DO NOT insulate the following, unless otherwise noted:

.1 Relief piping.

.2 Drain lines.

.3 Small branch risers to terminal heating elements just above floor level, from 150 mm [6"] below floor slab up to heating element.

.4 Flexible interconnections between ceiling radiant heating panels.

.3 Insulate the following valves and fittings if the pipe is insulated:

.1 Elbows, tees, reducers.

.2 Valve bodies on valves and check valves, over NPS 2-1/2".

.3 Flanges.

.4 Strainers.

.4 The following hot pipe fittings that operate at 49° C [120° F] shall be coated with Thermalite –SG as per manufacturer's specifications to prevent skin burns:

.1 Valves, NPS 2-1/2" and smaller.

.2 Valve bonnets.

.3 Unions.

.4 Flexible connections.

.5 Expansion joints.

.6 Check valve covers.

2.5 PIPE INSULATION THICKNESS TABLE - MM [INS]

	NOMINAL PIPE SIZE (NPS)					
Service	**Design Operating Temperature**	**Runouts 2 and less (note 1)**	**1 and less**	**$1^1/_4$ to 2**	**$2^1/$ to 4**	**5 and larger**
Hot Water Heating	50-90°C [120-200°F]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]
Hot Water Heating	96-120°C [205-250°F]	40 [1.5]	40 [1.5]	50 [2]	50 [2]	90 [3.5]

Part 3 Execution

3.1 APPLICATION

.1 Apply insulation to piping only after all tests have been made and systems accepted by Departmental Representative tight.

.2 Apply insulation and insulation finish in a workmanlike manner so that the finished product is uniform in diameter, smooth in finish, pleasing to the eye and with the longitudinal seams positioned to be concealed from view. Apply piping insulation materials, accessories and finishes in accordance with manufacturer's recommendations.

.3 On piping NPS 2-1/2 and larger with insulation and vapour barrier, install high density insulation above hanger shield. Insert to be slightly longer than the length of shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.

.4 Insulation and vapour barrier shall be continuous through all non-rated separations.

3.2 INSULATION TERMINATION POINTS

.1 Terminate insulation 75 mm [3"] back from all uninsulated fittings to provide working clearance and terminate insulation at 90° and finish with reinforced scrim cloth and vapour barrier mastic system. Cover onto pipe and over the insulation vapour barrier. On concealed hot services terminate insulation 75mm [3"] back from all uninsulated fittings, cut off at 90° and apply reinforced scrim cloth and breather mastic system.

.2 Cut back insulation at 45° and finish with a silicone caulking sealant around the base of thermometer wells, pressure gauges, flow switches and pressure and control sensors.

3.3 VERTICAL RISERS

.1 On vertical pipe over 75 mm [3"] provide insulation supports welded or bolted to pipe, directly above lowest pipe fitting. Thereafter, locate on 4.5 m [15 ft.] centres.

3.4 HOT APPLICATION 26.7^{O}C [80°F] AND OVER

.1 Piping:

.1 Install medium temperature pipe insulation with integral jacket to pipe and hold in place by stapling the flap, with spreading staples at 75 mm [3"] centres.

Pipe insulation with integral self-sealing jacket will not require additional fastening.

.2 Install strips of vapour barrier jacket over butt joints and secure with spreading staples.

.2 Fittings:

.1 Insulate fittings, to thickness of adjacent pipe insulation, with sections of the pipe insulation mitred to fit tightly, or with preformed insulation fittings (Shur-Fit) or from insulation fabricator.

.3 Valves, Strainers:

.1 Insulate valve bodies and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation or insulate with preformed insulation fittings (Shur-Fit) or from insulation fabricator. Drains, blowoff plugs and caps shall be left uncovered.

.4 Flanges and Victaulic Fittings:

.1 Do not insulate flanges on condenser/heat pump water piping inside the building.

.2 Insulate flanges on condenser/heat pump water piping outside the building.

.3 Insulate flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe insulation. Insulation to overlap adjoining insulation at least 75 mm [3"].

3.5 ANTI-SWEAT COATING

.1 Coat with an anti-sweat coating - "No Sweat" by Robson Thermal Mfg. Ltd. or approved alternate the following uninsulated cold surfaces:

.1 Connecting surfaces of thermometers, pressure gauges, flow switches, controllers, etc.

.2 The coating thickness shall be as recommended by the coating manufacturer for the system operation conditions.

3.6 PIPE INSULATION FINISHES

.1 "Concealed" insulation in horizontal and vertical service spaces will require no further finish.

.2 "Concealed" pipe insulation in damp locations, e.g. pipe trenches shall have a vapour barrier jacket, vapour sealed.

.3 "Exposed" flexible insulation shall be painted with a heavy brush coating of foam plastic white insulation coating.

.4 "Exposed" insulation inside the building shall be finished as follows:

.1 Premium Finish:

.1 Over a factory applied integral all-service type jacket on the pipe insulation, apply PVC jacket.

.2 Over insulated fittings apply PVC fitting covers. Over insulated valve bodies, valve bonnets, strainers and flanges apply purchased PVC covers

or field fabricate from PVC sheeting secured with solvent bonding cement.

.3 Finish fabric with one (1) coat of fabric coating.

.2 Economy Finish:

.1 Apply pipe insulation with an integral all-service type jacket. Cover longitudinal and circumferential joints with jacket finishing tape neatly applied. Alternately secure jacketing longitudinal joint using integral self- sealing lap. Cover circumferential joints with jacket finishing butt strips. Over wrap strips by 50 percent. For insulation O.D. 300 mm [12"] apply strips on 250 mm [10"] centres for additional securement. PVC, especially,

.020" thick should not be used as a vapour barrier alone. Should have 'ASJ' or mastic system under it. Over insulation on short pipe runs and piping adjacent to fittings, valves, etc., jacket to be field applied.

.2 Over insulated fittings apply tack coat of vapour barrier mastic and embed reinforcing membrane and cover with same mastic. Over insulated valve bodies, valve bonnets, strainers and flanges, apply all-service jacketing using necessary fastenings and jacket finishing tape and with the reinforced mastic system on irregular surfaces.

.3 "Exposed" outdoor insulation shall be finished as follows:

.1 Insulation shall have a vapour sealed vapour barrier jacket.

.2 Over the pipe insulation jacket apply aluminum weather protecting jacket. The longitudinal seam shall be located to shed water. Secure the jacket using necessary metal banding on approximately 250 mm (10") centres and at the overlaps. Screws are not permitted on cold operating systems, since they will penetrate the vapour barrier.

.3 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply metal jacket or preformed metal fittings to provide a complete jacket system. Secure with necessary fastenings.

.4 Seal all outdoor jacketing watertight.

3.7 FIRE STOPPING AND SMOKE SEALS

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

.2 Maintain insulation around pipes penetrating fire separation only as permitted by Firestop Assembly Listing.

.3 Submit Certificate of Inspection (Form MF173) that all work is complete and in accordance with the specified requirements before Substantial Completion.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 This section shall review the shop drawings of the fire alarm system as provided by Division 26, with respect to the devices affecting the mechanical control system (an integral part of the Fire Fighters Central Control Facility).

1.2 GENERAL

.1 The control system is to be fully microprocessor based no pneumatic actuation will be permitted.

.2 The controls system is to be complete with all necessary control components and connections to achieve the specified functions and to permit the H.V.A.C. systems to perform properly in the manner described and as hereinafter specified.

.3 The controls contractor shall furnish all materials, including all central computer(s) hardware and software, operator input/output peripherals, standalone DDC panels, automation sensors and controls, wiring. The controls contractor shall be responsible for the design, installation, supervision and labour services, calibration, all software programming, and checkout necessary for a complete and fully operational Building Automation System, as described in Section 23 09 24 Scope of Work.

.4 The control system is to be set up and adjusted to achieve optimum operation of the H.V.A.C. system. This includes sequencing, timing and readjustment, as required. Modifications to the sequence of operation using points indicated will not be considered as extra to the Contract. These modifications to continue through the construction period, commissioning period and warranty period as required to achieve optimum operation of the mechanical system.

.5 This Section is a performance specification clarified in certain sections to establish minimum standard of equipment, installation or level of control. The specification describes the basic functions required but not all of the installation details or components. This Trade is expected to have sufficient experience to be able to design and estimate the cost of an appropriate control system. Materials and work necessary to achieve a satisfactory result will not be considered extra to the contract.

.6 The contractor shall review all contract documents and visit the site if possible, prior to the closing date of the tender and site confirm the requirements regarding the routing of interconnecting transmission network, etc.

.7 When preparing shop drawings, review the proposed sequences, suggest improvements and review these with the Departmental Representative.

.8 Work with the other parties involved in commissioning, assess how the programming can be modified to improve function, review this with the Departmental Representative and modify the programming as instructed by the Departmental Representative.

.9 The control system shall be a modular, flexible and fully commissioned Direct Digital Control (DDC) System except that controls not scheduled on the points list may be electric. Items identified in the sequence of operation as being under DDC control but which are not included in the points list shall be included in the DDC system.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Sections 01 33 00 and 23 05 00.

.2 Shop drawings shall include:

.1 Control centre layouts.

.2 Manufacturer's descriptive technical literature for all equipment and devices.

.3 Interconnection schematics.

.4 Wiring and piping diagrams.

.5 One-line diagram from sensor and control points to Field Interface device and/or standalone DDC panel including all components and cables.

.6 Terminal cabinets, including termination listing.

.7 Written description indicating sequence of operation. Shop drawings will be rejected if the written description is not included with the submission. Sequences should reference English descriptors and labels for each point described.

.8 All input/output points which shall include the following information associated with each point.

.1 Sensing element type and location.

.2 Details of associated field wiring schematics and schedules.

.3 Schematics and schedules.

.4 Software and programming details.

.9 Detailed block diagrams of transmission trunk routing and configuration.

.10 Valve and damper schedules indicating size, configuration, capacity and locations. If size varies greater than 10%, obtain approval of Departmental Representative.

.11 Copies of all system graphics complete with system specific point labels.

.3 When submitting the controls shop drawings arrange a time to review these in detail in the Departmental Representatives office.

1.4 OPERATING & MAINTENANCE MANUALS

.1 The maintenance manual data is intended to cover the operation and maintenance of all control systems and equipment installed. Forward 3 copies of the Controls and Instrumentation section of the operating and maintenance manuals to the Balancing Agency to ensure the binding and format of material are compatible. Ensure sufficient time has been given to the Balancing Agency for the compiling of the complete operating and maintenance manuals by the commissioning deadline. One complete manual shall be furnished prior to the time that system or equipment tests are performed.

.2 The manuals shall include the name, address and telephone number of the control subcontractor installing the systems and a list of emergency numbers for service personnel. The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject.

.3 Manuals shall be furnished which provide full and complete coverage of the following subjects:

.1 Operational Requirements: This document shall describe, in concise English terms, all the functional and operational requirements for the system and its functions that have been established. It shall not require knowledge of digital processor programming or electronic techniques or control system theory.

.2 System Operation: Complete guidance and procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats and procedures; and emergency, alarm, and failure recovery procedures. Provide step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes.

.3 Functional Description: Detailed documentation, in language readily understandable to engineering personnel, of the theory of operation and specific functions of the system. Provide full details of data communications, including data types and formats, data processing and disposition data link components and interfaces and operator test or self-test of data link integrity for all system components and computer peripherals during each system function and operating mode. Hardware and software functions, interfaces, and requirements shall be explicitly detailed for all system components in all system functions and operating modes. Any operating procedures currently implemented or planned for implementation in an automatic mode shall be stated and described.

.4 Software: Documentation of the theory, design, interface requirements, and functions of all software modules and systems for all digital processors. Include test and verification procedures and detailed descriptions of program requirements and capabilities. Provide all data necessary to permit modification, relocation, or other reprogramming and to permit combination of new and existing software modules to respond to changing system functional requirements without disrupting normal control system operation. Include, as a minimum, for all software modules, fully annotated source code listings, error-free object code files ready for loading via a peripheral device, and complete program cross reference, plus any calling requirements, data exchange requirements, necessary subroutine lists, data file requirements, and other information necessary to ensure proper loading, integration, interfacing, and program execution. All DDC panel software shall be provided individually for each DDC panel while a single section shall reference all DDC panel common parameters and functions.

.5 Maintenance: Documentation of all maintenance on all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective units. Include calibration, maintenance, and repair of all sensors and controls, plus diagnosis and repair or replacement of all system hardware.

.6 Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as Test Procedures. A provision for the measurement or observation results, based on the previously published Test Specification, forms the Test Reports. The

procedures record and the results of these exercises shall be conveniently bound and documented together.

.4 Refer to Section 23 05 00 for additional requirements.

1.5 WARRANTY

.1 Refer to General Conditions.

.2 The system including all hardware and software components shall be warranteed for a period of one year following the date of final acceptance. Any manufacturing defects arising during this warranty period shall be corrected without cost to the Owner.

.3 All applicable software as detailed in this specification shall be updated by the Controls Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the Controls Contractor. All future patches to the software shall be made available to the Owner.

.4 Repairs required by a total system failure, or the malfunction of any priority portion of the system shall be considered an emergency repair, and shall be performed within eight (8) hours of the report of the failure.

.5 Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.

.6 Provide written assurance that a local service centre will be maintained with a complete stock of replacement parts, and capable of servicing any and all troubles in the system.

.7 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the General Conditions.

.8 Take note of and provide any extended warranties specified.

1.6 ELECTRICAL COMPONENTS, WIRING AND CONDUIT

.1 By Control Contractor (Division 23):

.1 All control system components to make a complete and operable system, except those supplied as part of packaged equipment controls, but including all auto-sequencing devices and electrical interlocks required to accomplish the sequences specified hereafter. Refer to the electrical equipment schedule, the electrical drawings and the electrical specification, which describes the limits of the extent to the work in Division 26 serving mechanical systems. Materials, equipment, connections and power not provided by Division 26 but required for the Control System shall be provided under this section.

.2 All control circuit transformers (120/1/60 or 24/1/60 and as designated).

.3 All control wiring and metallic conduit for mechanical system controls.

.4 Supply, installation and connection of all electric control items including: damper motors, relays, outside sensors, sub-master control circuits, safety devices, electric thermostats, aquastats, flow switches, wiring to terminal strips, proportional controllers, controllers, etc..

.5 All wiring and conduit from power distribution system to any control devices needing power (including B.A.S. components)

.6 Be responsible for coordinating with Division 26.

.7 Electrical work installed under Division 23 shall be to the standards specified under Division 26.

.2 By Division 26:

.1 All power wiring and conduit from power distribution system up to and including connection to all motors and starters.

.2 All disconnect switches required (unless specified in schedules as being integral with equipment).

.3 All motor protection switches, stop-start switches, magnetic starters, contactors and hand-off-automatic selector switches except those supplied as part of packaged equipment.

.4 Terminal strips within the motor control centres (MCC) for control connections.

.5 Fire alarm signals.

.3 Note:

.1 All magnetic starters for equipment shall have the following features supplied under Division 26:

.1 Hand-off-automatic selector or on-off selector, or start-stop buttons in cover with hand-automatic bridge if applicable.

.2 Pilot light.

.3 120 volt coils.

.4 120 volt control transformer.

.5 Four auxiliary dry contacts for interlocks; two normally open and two normally closed.

.2 The Controls Contractor is responsible for reading Division 26 plans and specifications to determine scope of responsibility and standards.

.4 Wiring:

.1 Carrier System:

.1 All wiring shall be run in EMT conduit except the final 900mm of wiring to all operators and to all sensors subject to vibration, which shall be run in flexible metallic conduit.

.2 Provide steel fittings with nylon throats for all conduit connections.

.2 Wire:

.1 Line voltage power or switched power wiring - #12 gauge copper wire minimum.

.2 Line voltage control wiring - #14 gauge copper wire, length not to exceed 50 meters; #12 gauge copper wire, lengths exceeding 50 meters.

.3 Low voltage - minimum #22 gauge wire as directed by applicable electrical codes and requirements. 24 gauge wire for thermostat cables

.3 Cable:

.1 Data transmission cable shall be minimum #18 gauge twisted pairs (shielding as per manufacturers recommendations).

.4 Note:

.1 Run carrier system parallel to building lines.

.2 Support conduit carrier system every one meter independent of piping, ductwork and equipment.

.3 All wiring shall be concealed in finished spaces.

.4 Seal all penetrations through fire separations or walls as per code requirements.

.5 Identify all junction box covers with control company label.

.6 Identify with colour bands, all conduits at all junction and pullboxes, at both sides of wall and floors and at not more than 7.5 m [25 Ft] intervals along the length. Identification bands to be sprayed on and not less than 100mm [4"] wide. Bands to be pink in colour unless in conflict with Division 16 colours.

.7 Use colour coded conductors.

.8 Adhere to all applicable electrical codes and regulations.

.9 Obtain electrical permit.

.10 For non-CSA equipment where required by electrical code, submit to Inspection Authorities and obtain approval prior to installation of equipment on site.

1.7 EQUIPMENT SUPPLIED FOR INSTALLATION UNDER OTHER SECTIONS

.1 The following equipment shall be supplied under this section but installed under the appropriate trade sections of Division 23:

.1 Automatic control valves.

.2 Temperature sensor wells.

.3 Automatic control dampers.

.4 Pressure tappings.

.5 Static pressure sensors.

.6 Flow switches.

.7 And other as called for in mechanical documents.

.2 The Controls Subcontractor shall be responsible for arranging, coordinating and supervising the installation of the above devices in a suitable manner and readily accessible location.

1.8 ALARMS - GENERAL

.1 No alarm shall be triggered for a device until the device has been started and is in stable operation. Use software time delays to achieve this effect.

.2 Generate an alarm on the B.A.S. if any equipment is not in the intended operating condition or if any analog input is not within the intended operating range.

1.9 IDENTIFICATION

.1 Identify all controls with symbols relating directly to the control diagram. Use plasticized tags, engraved brass, aluminum, metalphoto or lamicoid labels and secure them to, or adjacent to, the control devices with key chains or cable ties.

.2 All manual switches supplied by the this trade, unless they come with standard nameplates, shall be labelled with engraved lamicoid plastic nameplates to clearly indicate the service. Wording on nameplates shall be subject to approval by the Departmental Representative.

.3 Where "day" and "night" thermostats are adjacent to one another they shall be labelled with engraved lamicoid plastic nameplates.

.4 Motor control centre and motor starters should be provided with labels identifying that motors are under remote control.

.5 Mount an input/output layout sheet within each main DDC panel. This sheet shall include the name of the points connected to each controller channel.

.6 Identify all DDC panels and associated devices with symbols relating directly to the control diagram. Provide durable wire labels for each input and output point with the following information:

.1 Point descriptor.

.2 Point type and channel number.

.3 Corresponding DDC panel number.

1.10 SYSTEM COMMISSIONING AND CALIBRATION

.1 Program each standalone DDC panel immediately following installation.

.2 Set up and calibrate all control loops and sensors during the initial start-up of the systems and check, recalibrate and readjust as necessary during the Owner's Demonstration and Instruction period.

.3 Upon completion of the installation, perform all necessary testing and debugging operations satisfactorily.

.4 Perform all modifications and alterations as required to correct any deficiencies noted during these tests.

.5 Check sensor calibration and control system operation during the first heating season and prior to the first cooling season.

.6 Following each visit submit printed graphs of trend logs one week in duration with hourly samples for all analog inputs connected to each DDC panel.

1.11 VERIFICATION OF SYSTEM COMMISSIONING

.1 Preliminary Tests

.1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.

.2 Notify the Departmental Representative in writing at least seven days before testing is to take place stating the following:

.1 Location and part of system to be tested.

.2 Describe testing procedure and anticipated results.

.3 Provide all necessary testing equipment and personnel.

.4 Provide portable 2-way radios for communications during demonstrations. Provide three units on the same frequency and of sufficient power and quality as to be useful throughout the building.

.5 Perform tests in presence of the Departmental Representative.

.6 Demonstrate the proper operation of each component.

.7 Correct any deficiencies and re-test in the presence of the Departmental Representative, until designated part of the system performs satisfactorily.

.2 Final Operational Acceptance Test

.1 A final operational test of not less than thirty (30) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total installed and operational Control System to demonstrate that it is functioning properly in accordance with all requirements of this specification. The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software. If the equipment operates at an average effectiveness level (AEL) of at least 95% during the performance test period of thirty (30) consecutive calendar days, it will be deemed to have met the Acceptable Standard of Performance, and final acceptance of the system shall be made, provided the contractor has satisfied all other requirements of this specification. In the event the required AEL is not reached during the initial thirty (30) consecutive calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for thirty (30) consecutive calendar days. The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period. Downtime shall result whenever the control system is unable to fulfill all required functions detailed within this specification due to any malfunction of either BMS hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed. Downtime created by non-BMS equipment or activities will not be considered as downtime for the AEL calculation.

1.12 DEMONSTRATION AND INSTRUCTION TO OWNER

.1 The Controls Contractor shall provide the services of competent instructors who will give full instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general (canned) training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum. A training manual shall be provided for each trainee which describes in detail the data included in each training program. All equipment and material required for classroom training shall be provided by the Contractor.

.2 Training Program: The training program shall be accomplished in two phases.

.1 First phase: this phase shall be for a period of at five days at a time mutually agreeable between the Contractor and Owner. Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. First phase training shall include the following:

.1 General control system architecture.

.2 System communications.

.3 Operation of computer and peripherals.

.4 Elementary preventative maintenance.

.5 Report generation.

.6 Operator control functions.

.7 Colour graphics generation.

.2 Second phase: this phase of training shall be conducted four to eight weeks after system acceptance for a period of three days. The training shall include as a minimum, but not be limited to:

.1 A review of Phase 1 training.

.2 Equipment maintenance - this training shall include:

.1 General equipment layout.

.2 Trouble shooting of all control system components.

.3 Preventative maintenance of all control system components.

.4 Sensors and controls maintenance and calibration.

.3 Programming - this training shall include:

.1 System architecture.

.2 Application programs.

.3 DDC panel programming.

.4 Software access code review.

1.13 MAINTENANCE SERVICE DURING THE WARRANTY PERIOD

.1 The Contractor shall provide all services, materials and equipment necessary for the maintenance of the entire Control System, for a period concurrent with the warranty period. Any necessary material required for the maintenance work shall be provided by the Contractor.

.2 The Controls Contractor shall provide one minor inspection per quarter or as required by the manufacturer and two major inspections per year, and all service for the required maintenance.

.3 Major Inspections: these inspections shall include but not be limited to the following:

.1 Work as detailed hereinafter for minor inspections.

.2 Clean all peripheral equipment, CPU, interface panels, multiplexing panels and micro processor interior and exterior surfaces.

.3 Provide signal, voltage and system isolation checks of all CPU, interface panels, multiplexing panels and peripherals.

.4 Provide mechanical adjustments, new ribbons and necessary maintenance on printers.

.5 Check and/or calibrate each field input/output device.

.6 Run system software diagnostics as required.

.4 Minor Inspections: These inspections shall include but not be limited to the following:

.1 Provide visual and operational checks to all CPU, peripheral equipment, interface panels, multiplexing panels, and field devices.

.2 Change filter and check fan for all CPU's peripheral equipment as required.

.3 Provide complete back up of BMS system.

.4 Regular service calls: these calls shall be performed during regular working hours, 8:00 a.m. to 4:30 p.m. Monday through Friday excluding legal holidays.

.5 Emergency Service: the Owner will initiate service calls when there is indication that the control system is not functioning properly. The Contractor shall have qualified control personnel available during the warranty period to provide service to the "critical" control system components whenever required at no additional cost to the Owner. The Contractor shall furnish the Owner with a telephone number where the service mechanic can be reached at all times. The service mechanic shall be on the job ready to service the control system within the next eight (8) hours, after receiving a request for service and the work shall be performed continuously until the control system is back in reliable operating condition. Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.

.6 Records and Logs: records and logs shall be kept of each maintenance task.

.7 System Modifications: recommendations for system modification shall be provided in writing to the Departmental Representative. No system modification, including operating parameters and control settings, shall be made without prior approval.

.8 Software: provide implementation of all software maintenance updates. These shall be accomplished as required and full coordination with control system supervisory personnel shall be maintained.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 All control work and its integration to existing facility is to be done by base building approved control contractor.

1.2 SCOPE OF WORK

.1 All new DDC devices to be integrated and fully compatible with existing facility network.

.2 Coordinate with Departmental Representative for minimum general requirements meeting their standards in addition to those listed below.

1.3 GENERAL REQUIREMENTS

.1 Performance requirements of the Building Automation System (B.A.S.) and associated hardware and software are specified in this section and defines the minimum hardware and performance requirements.

.2 The B.A.S. system shall be a realtime, online, multitasking, multi-user, micro processor based system.

.3 All of the specified programming features must be written by the controls contractor and available for use by the owner. These features will all be tested and verified during commissioning. It shall not be satisfactory to merely provide software that is capable of these features if programmed by the owner.

.4 Environmental Conditions: The BAS and its immediate associated devices shall be able to operate properly under environmental conditions of 0 deg.C. to 44 deg.C. and a relative humidity of 10 to 95 percent noncondensing.

1.4 RADIO FREQUENCY INTERFERENCE (R.F.I.)

.1 Ensure that all equipment installed under this division is capable of operating properly when subjected to the ambient radio frequency signals existing at the site and in accordance with the Radio Interference Regulations (RIR).

.2 Take into consideration all A.M., F.M., T.V., U.H.F. and V.H.F. signals generated by private and commercial transmitters as well as spurious signals generated by hospital equipment such as X-ray and linear accelerator treatment equipment, etc.

.3 Provide traps as required to reduce all radio frequency and electromagnetic interference signals to acceptable levels.

1.5 SOFTWARE UPDATE

.1 Patches to the software package shall be provided at no cost for the life time of the system. These shall include all patches and fixes to the original software package supplied, but shall not necessarily include new software products subsequently released by the manufacturer after substantial completion.

1.6 SPARE PARTS

.1 Provide written assurance that in the event of a catastrophic failure of the system or portion thereof, the manufacturer or the system sub-contractor is able to obtain components for replacement with a maximum turn-around of 24 hours.

Part 2 Products

2.1 GENERAL PRODUCT DESCRIPTION

.1 The Building Management System (BMS) shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.

.2 The Building Management System shall consist of the following:

.1 Standalone Panels (SAPs).

.2 Terminal Unit Controllers (TUCs).

.3 Portable Operator's Terminals (POTs).

.4 Personal Computer Operator Work Station(s) (OWSs).

.3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, SAPs, applicable TUCs and operator devices.

.4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each SAP shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

.5 SAPs shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. SAPs shall also be able to send alarm reports to multiple operator work stations without dependence upon a central processing device.

.6 The Building Management System shall be capable of accepting Autocad drawing files. The Autocad drawings shall be interfacial with the control system graphics software via stripped down DWG files, which are converted into Windows Metafiles for use as graphics for BMS.

2.2 NETWORKING/COMMUNICATIONS

.1 Networking/Communications capabilities shall consist of:

.1 Peer to Peer Communications between SAPs.

.2 Operator Work Station Interconnection.

.3 Terminal Unit Controller (TUC) communications.

.4 Off-site modem communications.

.2 Peer to Peer Interpanel Communications:

.1 SAPs shall communicate with one another over a high speed peer to peer protocol communications bus. All devices on the bus shall be peers and no specific device shall be designated as the master for communications purposes. The failure of any one device on the peer bus shall not result in a loss of communications between any of the other devices on the bus.

.2 Communication protocol shall employ token passing or collision detection to manage access to the bus in a peer to peer fashion. Minimum baud rate shall be 38.4K and system throughout capability shall be sufficient to satisfy the requirements in Section 2.3.2.

.3 The system shall have the ability to establish priority levels in terms of accessing the peer bus. The peer protocol shall be able to distinguish between alarms, automatic data transfer, manual commands and database transfers and the relative priorities between these events shall determine their access to the bus and consequently the relative speeds of these transactions.

.3 Operator Work Station Interconnection:

.1 Operator work stations shall access the peer bus by either directly connection to a SAP via an RS232 port or directly to the peer bus. If directly connected, it shall be via a device that resides on the bus as a true peer with only one OWS per such device.

.2 The systems shall support multiple OWSs connected to the peer bus either through multiple SAPs or multiple peer devices or a combination of both. When changes are made to datafiles at one OWS (including but not limited to graphics files, graphics link files, point datafiles, point labels and panel datafiles), they shall be automatically updated at all other OWSs (except those that are off-site). This shall be accomplished directly over the peer bus or via a parallel Local Area Network (LAN).

.4 Terminal Unit Controller (TUC) Communications:

.1 TUCs shall communicate with one another and a higher order device on the peer bus via a communications bus with a minimum 9600 baud rate. The TUC communications bus shall access the main peer bus via an SAP or a node device that acts as a full peer on the main bus.

.2 The TUC communication protocol shall be either poll / response (with the peer device acting as the master) or peer to peer.

.5 Off-Site Modem Communications:

.1 Each SAP shall support a dial in / dial out modem for connection of an offsite OWS.

.2 SAP shall be able to automatically dial out to a user definable number upon the occurrence of any programmable event or alarm occurrence.

.3 The system shall support dialing in from an off-site OWS which will have all of the capabilities specified for a directly connected OWS. Provide hardware and software for OWS in "central maintenance operating department" with all capabilities as directly connect OWS. Allow for new OWS, if necessary in central maintenance operating building.

.4 The system for this project shall be provided complete with one autodial modem connected to one of the SAPs.

2.3 PROCESSING SPEED

.1 Effective Panel Processing Speed (All Panels):

.1 The maximum permissible execution time is TWO (2) seconds and is defined as follows:

.1 Execution Time:

.1 The time required for the CPU in the stand-alone panel to execute all application software in the panel, from the same point in the software back to the same point, assuming full memory usage as defined in 1.3, while simultaneously responding to operator or terminal display requests and carrying on normal inter-panel communications averaged over a ONE (1) minute period.

.2 The execution time will be verified by setting up a counter in each panel and monitoring the counting rate.

.3 Provide with the proposal the estimated execution time for each panel in the system as configured to this job.

.2 Effective System Processing Speed:

.1 The effective system processing speed applies to multi-panel systems only. The system processing speed is intended to address inter-panel communications and will be monitored by evaluating the delays in inter-panel data transfer.

.2 The effective system processing speed will be verified by initiating a cyclical flag in one panel every minute. This flag will initiate a counter and at the same time command a flag in a remote panel. The remote flag will be used to terminate the counter in the original panel. The value of the counter will be compared to a continuous counter over a one hour period to determine the average delay in inter-panel data transfer. The test will be carried out with the system fully commissioned and all memory requirements specified herein invoked.

.3 The maximum allowable delay for data transfer between SAPs shall be 5 seconds for normal data and 1 second for alarms (not including panel cycle times).

.4 If critical alarm generating points are connected to TUCs then the maximum delays for getting the information to the applicable SAP shall be as per 2.3.2.3 above.

.5 The maximum delay between an alarm event in a SAP or TUC and having that alarm annunciated to the OWS(s) shall be four (4) seconds including panel cycle time. This will be verified with the system fully loaded and commissioned.

2.4 STANDALONE PANELS (SAPS)

.1 General: SAPs shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each SAP shall consist of all required hardware including but not limited to processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

.2 Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:

.1 Control processes

.2 Energy Management Applications

.3 Alarm Management

.4 Historical/Trend Data for all points

.5 Maintenance Support Applications

.6 Custom Processes

.7 Operator I/O

.8 Dial-Up Communications

.9 In addition to the memory required to accommodate all of the points and sequences specified, each SAP shall have memory capacity to accommodate trending of all inputs and outputs with 100 samples per point. This shall include all points connected to subordinate TUCs if they do not have their own on-board trending capabilities.

.3 Point Types: Each DDC panel shall support the following types of point inputs and outputs if applicable:

.1 Analog inputs:

.1 4 - 20 Milliamps

.2 0 - 10 Volts DC

.3 120 Volts AC

.4 10,000 ohm thermistor

.5 100,000 ohm thermistor

.6 100 or 1000 ohm Pt

.7 1000 ohm Ni

.8 20.7 - 103.4 kPa [3 - 15 psi] (via external transducer)

.2 Digital inputs:

.1 Dry contact closure

.2 Pulse accumulator (i.e. electrical consumption)

.3 Actuators/Output Signals:

.1 Digital outputs (contact closure):

.1 Motor starters, sizes 1 to 4 (via external relays)

.2 Analog outputs:

.1 4 - 20 Milliamps

.2 0 - 10 Volts DC

.3 Triac 24 Volts AC

.4 20.7 - 103.4 kPa [3 - 15 psi] (via external transducer).

.4 The DDC panel electronics shall be housed in a metal cabinet with keylock utilizing a master key.

.5 Spare Points: The system shall have spare points capacity for future use. Housed in one specific DDC panel in each mechanical room the spares shall be comprised of not less than six analog and ten digital inputs as well as six analog and ten digital outputs. These shall not require any vendor specific hardware or software to utilize.

.6 Expandability: The system architecture shall support a future system capacity of 5000 control points including points connected to SAPs and TUCs.

.7 Serial Communication Ports: SAPs shall provide at least two (2) serial data communication ports in addition to the network communication port, for simultaneous operation of multiple operator I/O devices such as industry standard printers, OWSs and Portable Operator's Terminals. SAPs shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

.8 Hardware Override Switches: The operator shall have the ability to manually override automatic or centrally executed commands at the SAP via local, point discrete, onboard hand/off/auto operator override switches for binary control points and analog control type points.

.9 Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication.

.10 Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as line voltage wiring where acceptable by electrical code.

.11 Powerfail Restart:

.1 In the event of the loss of normal power, there shall be an orderly shutdown of all SAPs to prevent the loss of database or operating system software. Non-Volatile memory (EPROM, EEPROM or FLASH RAM) shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

.2 Provide automatic power failure routine to accomplish orderly shutdown of the automation system when loss of power is detected. Do not place any equipment in an unacceptable or dangerous condition as a result of power failure or restart procedures.

.3 Restart the system automatically and in an orderly fashion upon power restoral.

.4 Restart equipment based on priority to minimize in-rush currents as large loads are reintroduced.

.5 Restart only those systems or loads which were operating at the time of shutdown.

.6 Alarm any equipment which fails to restart when requested.

.7 Provide manual restart lockout capability.

.12 Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

.13 Should SAP memory be lost for any reason, the system shall generate an alarm. The user shall have the capability of reloading the SAP via an OWS which is either on-site or via modem.

2.5 SYSTEM SOFTWARE FEATURES

.1 General:

.1 All necessary software to form a complete operating system as described in this specification shall be provided. The software shall become the property of the Building Owner, who shall have full control over its use (within the confines of the Project). Provide the user with all necessary access codes to all levels of software programming and control system access including custom DDC programming. The quoted cost shall include for all necessary licensing, fees, cost, agreement requirements etc. so that the Owner has unrestricted use of the software.

.2 The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

.2 Control Software Description:

.1 Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:

.1 Two Position Control.

.2 Proportional, Integral, plus Derivative Control.

.3 Floating three position control (where specified).

.2 Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

.3 Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.4 Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

.3 Energy Management Applications: SAPs shall have the ability to perform any or all of the following energy management routines:

.1 Time of Day Scheduling

.2 Calendar Based Scheduling

.3 Holiday Scheduling

.4 Temporary Schedule Overrides

.5 Optimal Start

.6 Optimal Stop

.7 Night Setback Control

.8 Enthalpy Switchover (Economizer)

.9 Peak Demand Limiting

.10 Temperature Compensated Load Rolling

.11 Fan Speed/CFM Control

.12 Heating/Cooling Interlock

.13 Supply Air Reset

.14 Hot Water Reset

.15 All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

.4 Custom Process Programming Capability: SAPs shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

.1 Process Inputs and Variables: It shall be possible to use any of the following in a custom process:

.1 Any system-measured point data or status

.2 Any calculated data

.3 Any results from other processes

.4 User-Defined Constants

.5 Arithmetic functions (+,-,*,/, square root, exp, etc.)

.6 Boolean logic operators (and, or, exclusive or, etc.)

.7 On-delay/Off-delay/One-shot timers

.2 Process Triggers: Custom processes may be triggered based on any combination of the following:

.1 Time interval

.2 Time of day

.3 Date

.4 Other processes

.5 Time programming

.6 Events (e.g., point alarms)

.3 Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other panels on the system including SAPs and TUCs

.1 In addition, a single process shall be able to issue commands to points in any and all other panels on the system including SAPs and TUCs.

.4 Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

.5 All SAPs must be fully user custom programmable. Application specific controllers will not be accepted except for TUC applications as noted in the points list.

.5 Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. SAP shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Work station or local I/O device, or communications with other panels on the network.

.1 Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

.2 Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

.3 Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

.4 Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 50-character alarm message to more fully describe the alarm condition or direct operator response. Each SAP shall be capable of storing a library of at least 250 Alarm Messages.

.5 Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

.6 Historical Data and Trend Analysis: Trend analysis shall be time event and/or deviation based and must be capable of graphing at least 8 separate trends simultaneously. A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

.1 Continuous Point Histories: SAPs shall store Point History Files for all analog and binary inputs and outputs (minimum of 100 samples per point).

.2 Dynamic Control Loop Performance Trends: SAPs shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds for verification of control loop performance.

.3 Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-defineable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours shall be provided. Each SAP shall have a dedicated buffer or capability of down loading to an on-line data storage and retrieval computer for trend data, and shall be capable of storing a minimum of 5000 data samples.

.4 Data Storage and Archiving: Trend data shall be stored at the SAPs, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

.7 Runtime Totalization: SAPs shall have the ability to accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

.1 The Totalization routine shall have a sampling resolution of one minute or less.

.2 The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

.8 Analog/Pulse Totalization: SAPs shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

.1 Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, litres, KBTU, tons. etc.).

.2 The Totalization routine shall have a sampling resolution of one minute or less.

.3 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

.9 Event Totalization: SAPs shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

.1 The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

.2 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.6 TERMINAL UNIT CONTROLLERS (TUCS)

.1 Terminal Unit Controllers (TUCs) shall be used to control terminal equipment and other miscellaneous points as noted on the points list.

.2 Each TUC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each TUC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

.3 Each TUC shall have sufficient memory to support its own operating system and data bases including:

.1 Control Processes

.2 Energy Management Applications

.3 Portable Operators Terminal (POT)

.4 The operator interface to any TUC point data or programs shall be through any OWS or any POT connected to any SAP or TUC in the network.

.5 TUCs shall directly support the temporary use of a POT. The capabilities of the portable operators terminal shall include, at minimum, the following:

.1 Display temperatures

.2 Display status

.3 Display setpoints

.4 Display control parameters

.5 Override binary output control

.6 Override analog setpoints

.7 Modification of gain and offset constants

.8 Program parameter adjustments

.9 Trend log displays edit/create trend logs

.10 Display/Command any point connected to any TUC or SAP in the system.

.6 Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller. TUCs shall employ EEPROM or FLASH RAM for this functionality.

.7 Application Descriptions:

.1 VAV and Perimeter Radiation controls only. Terminal Unit Controllers shall support, but not be limited to, the control of the terminal units to address current requirements as described in the Execution portion and points list of this specification.

.2 It is anticipated that TUCs will be application specific and thus not custom user programmable. The application software provided with the TUCs shall meet the requirements of the sequences of operation as specified herein and the programming and potential subsequent reprogramming of the TUCs shall be subject to clause 1.2.4 in Section 23 09 01.

.3 For TUCs used in VAV applications, they shall have a built-in solid state flow transmitter for sensing air flow. Heated wire flow sensors will not be acceptable. It shall be the responsibility of this contractor to ensure that the flow transmitter is compatible with the velocity pressure probe supplied with the VAV box.

2.7 OPERATOR INTERFACE

.1 Basic Interface Description

.1 Command Entry/Menu Selection Process: Operator Work station interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.

.2 Graphical and Text-Based Displays: At the option of the user, Operator Work stations shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all work stations.

.3 Multiple, Concurrent Displays: The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance. If the interface is unable to display several different types of displays at the same time, the controls contractor shall provide at least two operator stations.

.4 Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit work station control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

.1 Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.

.2 A minimum of four levels of access shall be supported.

.3 A minimum of 50 passwords shall be supported at each DDC panel.

.4 Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log-on.

.5 User-defineable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

.6 It shall be possible to limit which points in the system that a particular operator has access to.

.5 Operator Commands: The operator interface shall allow the operator to perform all commands required to operate or program the entire system.

.6 Logs and Summaries: Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:

.1 A general listing of all points in the network.

.2 Individual lists of all points currently in alarm, off-line, in override status, disabled, or locked out.

.3 List all Weekly Schedules.

.4 List all Holiday Programming.

.5 List of Limits and Deadbands.

.6 Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

.7 Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and boiler systems, shall be provided as specified herein to optimize system performance analysis and speed alarm recognition.

.1 System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.

.2 Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

.3 Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

.1 Libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols shall be provided.

.2 The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

.1 Define symbols

.2 Position and size symbols

.3 Define background screens

.4 Define connecting lines and curves

.5 Locate, orient and size descriptive text

.6 Define and display colors for all elements

.7 Establish correlation between symbols or text and associated system points or other displays.

.3 Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including Terminal Unit Controllers used for DDC unitary or VAV terminal unit control.

.4 Pre-Constructed Graphics

.1 Provide a complete set of pre-constructed graphics for use with the system at time of hand-over.

.2 Provide, at minimum the following dynamic graphics.

- Hot water heating system.

.8 System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

.1 The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

.1 Add/Delete/Modify SAPs, Modify Operator Work stations, TUCs.

.2 Add/Delete/Modify points of any type, and all associated control loops, point parameters, and tuning constants.

.3 Add/Delete/Modify Totalization, Historical Data Trending for every point.

.4 Add/Delete/Modify custom control processes and all graphic displays, symbols, and cross-references to point data.

.5 Add/Delete/Modify dial-up telecommunication definition, operator passwords and Alarm Messages.

.2 System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.

.3 Database Save/Restore/Back-Up: Back-up copies of all standalone panel databases shall be stored in at least one personal computer operator work station. Continuous supervision of the integrity of all SAP data bases shall be provided. In the event that any SAP on the peer bus experiences a loss of its data base for any reason, the system shall automatically download a new copy of the respective data base to restore proper operation. Data base back-up / download shall occur over the peer bus without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of a SAP data base.

END OF SECTION

1 General

2 Products – Refer To Section 23 09 13

2.1 HOT WATER HEATING SYSTEM CONTROL:

.1 Major Components:

.1 Hot water boilers B-I1, B-I2 (ITF Building) & B-C1,B-C2 (CTF Building).

.2 Primary hot water pumps P-I1, P-I2 (ITF Building) & P-C1, P-C2 (CTF Building).

.3 Interlocks for B-I1 and P-I1, B-I2 and P-I2, B-C1 and P-C1, B-C2 & P-C2 (wired to boilers).

.4 Secondary water pumps P-I5, P-I6 (ITF Building) & P-C5, PC-6 (CTF Building) (variable volume pumps, one duty and one standby).

.2 Nominal operating temperatures and pressures:

.1 Primary hot water from boilers: 68°C [155°F] to maintain RWT (return water temperature) of 49°C [120°F]

.2 Start with low supply water temperature set-point (to the secondary loops), and monitor space temperatures. If the load is not met (rooms trend further below room temperature set-point), the supply water temperature set-point to increase. When the room temperatures are stable, and the return water temperature trends up (temperature rises), the supply water temperature to decrease (to find the optimal low supply water temperature, which satisfies the building loads).

.3 Boiler Control:

.1 Sequencing of the boilers shall be by the BMS. The BMS shall cycle the boilers on and off, to best match the load conditions and to optimize the energy consumption of the boilers at all times.

.2 The BMS shall monitor a request to start each boiler and shall enable the boilers to operate as required.

.3 Provide heating hot water reset signal to the boilers' control panel.

.4 The firing order of the boilers is to be selectable. Lead boiler shall switch on every call for heating.

.5 If B-3 cannot meet the demand, the BMS will enable B-1 or B-2, and disable B-3.

.6 BMS will enable the Lag boilers in sequence, if required.

.7 Provide lead-lag control to alternate B-I1 & B-I2 (ITF Building) on every start signal.

.8 Provide lead-lag control to alternate B-C1 & B-C2 (CTF Building) on every start signal

.9 If one boiler fails to operate, the BMS shall automatically start the next boiler. An alarm signal shall be sent to BMS

.4 Boiler Pumps Heating Hot Water Circulation System Control

.1 The variable flow primary hot water pumps P-I1 and P-I2 are dedicated to boilers B-I1 and B-I2 (respectively). Each pump is to be interlocked to the respective boiler.

.2 The variable flow primary hot water pumps P-C1 and P-C2 are dedicated to boilers B-C1 and B-C2 (respectively). Each pump is to be interlocked to the respective boiler.

.3 The boiler shall fire up upon the proven water flow via the flow switch.

.4 Lead boiler pump shall modulate to maintain low return water temperature to the boiler. (Typical for both buildings)

.5 Secondary Heating Hot Water Circulation System Control

.1 The variable volume secondary hot water pumps P-I5, P-I6 (IFT Building) and P-C1, P-C2 (CTF Building) are each sized for 100% design flow (Duty/Standby).

.2 The BMS shall select one of the scheduled water pumps to be the "lead" pump. The lead pump shall be alternated by the BMS on a weekly basis.

.3 If one pump fails to operate (as sensed by the current sensors), the BMS shall automatically start the "lag" pump. An alarm shall be sent to BMS.

.4 The BMS shall control the secondary hot water pump VSD to maintain hot water system differential pressure, measured at a couple of the furthest heating coils.

.5 Heating water flow through the pressure bypass pipe shall be self-balancing

.6 Lead pump modulates to maintain loop differential pressure.

.7 When pump is at minimum flow, the bypass valve (CV-BP) modulates to maintain differential pressure in the loop.

2.2 AIR HANDLING UNIT HEATING COIL (AHU-1, AHU-2 & AHU-3):

.1 Air handling unit controls remain unchanged.

.2 Connect new respective heating temperature control valve and heating loop pump.(P-I3, P-I4 and P-C3).

.3 On call for heat, respective pump starts, and heating control valve modulates to maintain supply air temperature set-point.

.4 Heating coil pump operates continuously when outdoor air temperature is below 2°C (adjustable).

END OF SECTION

1 GENERAL

1.1 General

.1 The following points list indicates the input and output points that shall be connected to the B.A.S. Any additional points that are noted in Section 23 09 93 to be under DDC control shall also be included as if they were on the points list. All points associated with one mechanical system shall be connected to the same Stand Alone Panel (SAP). All points shall be connected to SAPs unless they are specifically noted in the points list as TUC points or if the TUC meets the same specifications for user custom programmability as the SAP in Section 23 09 24.

.2 Program alarms as specified in the points list and sequences with user adjustable alarm thresholds. Provide descriptors for all programmed alarms which can be accessed via the graphics at the OWS(s).

1.2 Device Legend

.1 Refer to Section 23 09 13 for specification of devices.

.2 RTS = Room Temperature Sensor

.3 DTS = Duct Temperature Sensor

.4 ITS = Immersion temperature Sensor

.5 ATS = Averaging Duct Temperature Sensor

.6 OTS = Outdoor Temperature Sensor

.7 HS = Humidity Sensor

.8 DPT = Differential Pressure Transmitters

.9 SPT = Static Pressure Transmitter

.10 VPT = Velocity Pressure Transmitter

.11 PSW = Pressure Switch

.12 TSW = Temperature Switch

.13 IPT = Current / Pneumatic Transducer

.14 CR = Current Relay

.15 EPR = Electric / Pneumatic Relay

.16 FSW = Flow Switch

.17 ESW = End Switch

.18 ER = Electric Relay

.19 DME = Damper Actuator Modulating Electronic

.20 DTE = Damper Actuator Two Position Electronic

.21 DMP = Damper Actuator Modulating Pneumatic

.22 DTP = Damper Actuator Two Position Pneumatic

.23 DMI = Damper Actuator Modulating Incremental Control

.24 VME = Valve Actuator Modulating Electronic

.25 VTE = Valve Actuator Two Position Electronic

.26 VMP = Valve Actuator Modulating Pneumatic

.27 VTP = Valve Actuator Two Position Pneumatic

.28 VMI = Valve Actuator Modulating Incremental Control

.29 MFT = VAV Box Flow Transmitter

.30 FMS = Electronic Flow Measuring Station

.31 WFS = Water Flow Measuring Station

1.3 Table Legend

.1 **DI** = DIGITAL INPUT; **DO** = DIGITAL OUTPUT; **AI** = ANALOG INPUT; **AO** = ANALOG OUTPUT; **X** = TUC POINT; **H** = HIGH ALARM; **L** = LOW ALARM; **S** = STATUS ALARM

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Section 23 09 94
Points List

DEVICE TYPE
REFER TO SECTION 15920 [23 09 13] FOR SPECIFICATION DEVICES

ATS AVERAGING DUCT TEMPERATURE SENSOR
AUX AUXILIARY CONTACT
CO2 CO2 & VOC SENSOR
CS CURRENT SENSOR
DC DOOR CONTACT
DHS DUCT HUMIDITY SENSOR
DME DAMPER ACTUATOR MODULATING ELECTRONIC
DPS DAMPER POSITION (POSITIVE FEEDBAK)
DPT DIFFERENTIAL PRESSURE TRANSMITTERS
DTE DAMPER ACTUATOR TWO POSITION ELECTRONIC
DTS DUCT TEMPERATURE SENSOR
ER ELECTRIC RELAY
ES ENERGY STATION (FLOW, SUP. TEMP,& RET. TEMP.)
ESW END SWITCH
FMS ELECTRONIC FLOW MEASURING STATION
FS FREEZE STAT
FST FLOW STATION (flow measuring device)
FSW FLOW SWITCH
HS HUMIDITY SENSOR
ITS IMMERSION TEMPERATURE SENSOR
MFT VAV BOX FLOW TRANSMITTER
OTS OUTDOOR TEMPERATURE SENSOR
OAH OUTDOOR AIR HUMIDITY SENSOR
PSW PRESSURE SWITCH
ROS ROOM OCCUPANCY SENSOR
RTS ROOM TEMPERATURE SENSOR
RT&HS ROOM TEMPERATURE AND HUMIDITY SENSOR
RY RELAY
SD SMOKE DETECTOR SENSOR
SPT STATIC PRESSURE TRANSMITTER
VME VALVE ACTUATOR MODULATING ELECTRONIC
ROS ROOM OCCUPANCY SENSOR
VPS VALVE POSITION (POSITIVE FEEDBAK)
VPT VELOCITY PRESSURE TRANSMITTER
VSD VARIABLE FREQUENCY DRIVE
VTE VALVE ACTUATOR TWO POSITION ELECTRONIC
WCS WINDOW CONTACT SWTICH
WFS WATER FLOW MEASURING STATION
WM WATER METER
WTS WELL TEMPERATURE SENSOR
TS TEMPERATURE SENSOR

POINTS LIST

No.	POINT DESCRIPTION	POINT LABEL		POINT LOCATION	DIGITAL IN	DIGITAL OUT	ANALOGUE IN	ANALOGUE OUT	COMMENTS
AHU's Unit (Typical) (refer to drawings and equipment schedules for quantities) :									
	Heating Coil Valve	AHU	HC				VPS	VME	
	Heating Coil Pump	AHU	P(HC)			HOA	CS		
Boiler (Typical) (refer to drawings and equipment schedules for quantities):									
	Boiler Water Set Point Adjustment	B-XX	HWSPT					0-10V	(Allow for signal 5-20mA)
	Boiler Water Supply Temp.	B-XX	HWST				ITS		
	Boiler Water Return Temp.	B-XX	HWRT				ITS		
	Boiler general alarm	B-XX			AUX				
	Boiler Flow Switch	B-XX	B-FSW		FSW				
boiler loop pumps (variable speed) (P-I1, PI-2, PC-1 and P-C2):									
	Pump Start/Stop (Command)	P-XX	C			ER			VSD bypass
	Pump Status	P-XX	S				CS		VSD bypass
	Pump VSD Start / Stop and Feedback	P-XX	CVSD-CS			ER	CR		Through BAC-Net (Also Speed, Power Status,...etc)
	Pump VSD Output	P-XX	CVSD					VSD	Through BAC-Net
	Pump VSD Alarm	P-XX	CVSD-A		AUX				Through BAC-Net
	Boiler Water Supply Temp.	B-XX	HWST				ITS		
	Boiler Water Return Temp.	B-XX	HWRT				ITS		
	Pump VSD Manual Reset	P-XX	VSD-MR			ER	CR		Through BAC-Net

DEVICE TYPE
REFER TO SECTION 15920 [23 09 13] FOR SPECIFICATION DEVICES

- ATS AVERAGING DUCT TEMPERATURE SENSOR
- AUX AUXILIARY CONTACT
- CO2 CO2 & VOC SENSOR
- CS CURRENT SENSOR
- DC DOOR CONTACT
- DHS DUCT HUMIDITY SENSOR
- DME DAMPER ACTUATOR MODULATING ELECTRONIC
- DPS DAMPER POSITION (POSITIVE FEEDBAK)
- DPT DIFFERENTIAL PRESSURE TRANSMITTERS
- DTE DAMPER ACTUATOR TWO POSITION ELECTRONIC
- DTS DUCT TEMPERATURE SENSOR
- ER ELECTRIC RELAY
- ES ENERGY STATION (FLOW, SUP. TEMP,& RET. TEMP.)
- ESW END SWITCH
- FMS ELECTRONIC FLOW MEASURING STATION
- FS FREEZE STAT
- FST FLOW STATION (flow measuring device)
- FSW FLOW SWITCH
- HS HUMIDITY SENSOR
- ITS IMMERSION TEMPERATURE SENSOR
- MFT VAV BOX FLOW TRANSMITTER
- OTS OUTDOOR TEMPERATURE SENSOR
- OAH OUTDOOR AIR HUMIDITY SENSOR
- PSW PRESSURE SWITCH
- ROS ROOM OCCUPANCY SENSOR
- RTS ROOM TEMPERATURE SENSOR
- RT&HS ROOM TEMPERATURE AND HUMIDITY SENSOR
- RY RELAY
- SD SMOKE DETECTOR SENSOR
- SPT STATIC PRESSURE TRANSMITTER
- VME VALVE ACTUATOR MODULATING ELECTRONIC
- ROS ROOM OCCUPANCY SENSOR
- VPS VALVE POSITION (POSITIVE FEEDBAK)
- VPT VELOCITY PRESSURE TRANSMITTER
- VSD VARIABLE FREQUENCY DRIVE
- VTE VALVE ACTUATOR TWO POSITION ELECTRONIC
- WCS WINDOW CONTACT SWTICH
- WFS WATER FLOW MEASURING STATION
- WM WATER METER
- WTS WELL TEMPERATURE SENSOR
- TS TEMPERATURE SENSOR

POINTS LIST

No.	POINT DESCRIPTION	POINT LABEL		POINT LOCATION	DIGITAL IN	DIGITAL OUT	ANALOGUE IN	ANALOGUE OUT	COMMENTS
Secondary water loop pumps (variable speed) (P-I4, PI-5, PC-4 and P-C5):									
	Pump Start/Stop (Command)	P-XX	C			ER			VSD bypass
	Pump Status	P-XX	S				CS		VSD bypass
	Pump VSD Start / Stop and Feedback	P-XX	CVSD-CS			ER	CR		Through BAC-Net (Also Speed, Power Status,...etc)
	Pump VSD Output	P-XX	CVSD					VSD	Through BAC-Net
	Pump VSD Alarm	P-XX	CVSD-A		AUX				Through BAC-Net
	Differencial Pressure	P-XX	DP				X		Through BAC-Net
	Pump minimum flow by pass control valve	P-XX	CV-BP				VPS	VME	Through BAC-Net
	Pump VSD Manual Reset	P-XX	VSD-MR			ER	CR		Through BAC-Net

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 Refer to Section 23 05 49 for required seismic restraint of piping.

1.2 REFERENCE STANDARDS

.1 Do all piping system work in accordance with ANSI/ASME B31.9 code.

1.3 REGULATORY REQUIREMENTS

.1 All components, products and fabrication techniques shall be provided in compliance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

.2 Installation of, and repair or alterations to, pressure piping systems shall be performed only by licensed Contractors and licensed Welders, certified for the work being done in accordance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

.3 All field welding to be in accordance with the procedures of CSA-W117.2 and the current edition of ASME Code for Power Piping and Building Services Piping.

1.4 SYSTEM PRESSURE RATINGS

.1 Pipe Fittings:

.1 Piping systems 860 kPa [125 psig] or less operating pressure - 860 kPa [125 psig] rating.

.2 Valves:

.1 Suitable for maximum system operating temperature and pressure.

Part 2 Products

2.1 GENERAL

.1 All products shall be registered with the regulatory authority in accordance with CSA B51.

2.2 PIPE

.1 Steel Pipe:

.1 to NPS 10, Schedule 40 to ASTM A53 Grade B.

.2 to NPS 12 and over, 9.5 mm [0.375"] wall thickness to ASTM A53 Grade B.

.3 for the following systems:

.1 Hot water heating

.2 Chemical feed

.3 Relief valve vents

.2 Steel and Stainless Steel Pipe:

.1 to NPS 8, Schedule 80 to ASTM A53 Grade B.

.2 to NPS 10 and over, 12.7 mm [1/2"] wall thickness to ASTM A53 Grade B.

.3 Galvanized Steel Pipe: to ASTM A53, Grade B, galvanized with average coating of 0.55 kg/sq.m. as follows:

.1 Schedule 40

.2 for the following systems:

.1 Pressure drains: NPS 2-1/2 and over.

.4 Copper Pipe: to ASTM B88M-86, Type K, or L hard drawn copper tubing.

.1 Type L, hard drawn:

.1 Pressure drains (to NPS 2).

.2 Type L hard drawn may be used as an alternative to steel piping for the following systems:

.1 Hot water heating.

.3 Type K, hard drawn:

.1 Air vent overflow where exposed.

.4 Type K, soft drawn:

.1 Air vent overflow where concealed.

2.3 PIPE JOINTS - STEEL PIPING

.1 NPS 2 and under: screwed fittings, except where otherwise noted, with teflon tape and rectroseal teflon paste or pipe dope.

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W47.1.

.3 Flanges: raised face, steel weld neck, lap or back-welded slip on type. Use flat face for attachment to cast iron valves.

.4 Bolts and Nuts, carbon steel: to ANSI B18.2.1 and ANSI B18.2.2.

.5 Flange gaskets:

.1 Up to 860 kPa [125 psig] system pressure - non-asbestos gaskets for mating surfaces.

2.4 PIPE FITTINGS - STEEL PIPE

.1 Pipe fittings, screwed, flanged or welded:

.1 Cast iron pipe flanges: Class 125 to ANSI B16.1.

.2 Cast iron screwed fittings: Class 125 to ANSI B16.3.

.3 Steel pipe flanges and flanged fittings: to ANSI B16.5.

.4 Steel butt-welding fittings: to ANSI B16.9a.

.5 Unions, malleable iron ground joint type: Class 150 to ANSI B16.3.

2.5 PIPE JOINTS - COPPER PIPE

.1 All sizes, soldered or brazed as specified in EXECUTION.

2.6 PIPE FITTINGS - COPPER PIPE

.1 Cast bronze: to ANSI B16.18.

.2 Wrought copper and bronze: to ANSI B16.22.

2.7 FLANGES - COPPER PIPE

.1 Brass or bronze: to ANSI B16.15.

.2 Cast iron: to ANSI B16.4.

2.8 VALVES GENERAL

.1 Include lock shield handles where shown or noted.

.2 Include chain wheel and chain where shown or noted.

.3 Use non-rising stem valves where there is insufficient clearance for stem to rise.

.4 Where butterfly valves are installed to permit removal of equipment, they shall be of the threaded full lug type. They may however, be of the wafer type if an additional pair of flanges (not those installed to contain the valve) are installed.

.5 Wherever possible all valves shall be of one manufacturer.

2.9 GATE VALVES

.1 NPS 2 and under, screwed:

.1 Bronze body, rising stem, solid wedge disc, union or screwed bonnet.

.2 Acceptable Products:

.1 Class 125 [860 kPa] - Crane 1700, Grinnell 3010, Kitz 24, Newman Hattersley 607, Nibco T-134, Toyo 293.

.2 NPS 2 and under, soldered:

.1 Bronze body, rising stem, solid wedge disc, screwed bonnet.

.2 Acceptable Products:

.1 Class 200 W.O.G. [1380 kPa] - Crane 1700S, Grinnell 3080SJ, Kitz 44, Newman Hattersley 607C, Nibco S-134, Toyo 299.

.3 NPS 2-1/2 and over, flanged:

.1 Cast iron body, rising stem, O.S. & Y, solid wedge disc, bronze trim, bolted bonnet.

.2 Acceptable Products:

.1 Class 125 [860 kPa] - Crane 465-1/2, Grinnell 6020A, Kitz 72, Newman Hattersley 504, Nibco F-617-0, Toyo 421A.

2.10 GLOBE VALVES

.1 NPS 2 and under, screwed:

.1 Bronze body, rising stem, renewable composition or bronze disc, union bonnet.

.2 Acceptable Products:

.1 Class 125 [860 kPa] - Crane 1703, Grinnell 3240, Kitz 03, Newman Hattersley 14, Nibco T-235-Y, Toyo 220.

.2 NPS 2 and under, soldered:

.1 Bronze body, rising stem, renewable composition or bronze disc, screwed bonnet.

.2 Acceptable Products:

.1 Class 200 W.O.G. [1380 kPa] - Crane 1703S, Grinnell 3240SJ, Kitz 10, Newman Hattersley 51, Nibco S-211-YW, Toyo 212.

2.11 BUTTERFLY VALVES

.1 NPS 2-1/2 and over:

.1 Cast iron or ductile iron body with ductile iron plated or bronze disc, stainless steel stem and extended neck to clear minimum of 50 mm [2"] thick insulation.

.2 Threaded full lug type or wafer type (with or without integral flanges).

.3 Resilient EPT or EPDM seat.

.4 Operators (unless otherwise specified in Section 15900):

.1 NPS 8 and under - lever handle with minimum 10 position ratchet and disc position indicator.

.2 NPS 10 and over - worm gear operator.

.5 Acceptable Products:

.1 Class 150 [1030 kPa] W.O.G. - Crane, Centreline, Demco, Dezurik, Grinnell, Keystone, Kitz, Kurimoto, Newman Hattersley, Nibco WD-2100 or LD-2100, Norriseal, Apollo 141 or 143

2.12 BALL VALVES

.1 NPS 2 and under, screwed:

.1 Forged brass body, threaded cap, chrome plated ball, PTFE seats, blow out proof stem.

.2 Ball valves for isolation service shall have a large/full port.

.3 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.

.4 Acceptable Products:

.1 Class 600 W.O.G. [4140 kPa] - Crane F9202, Grinnell 3700, Kitz 58, Newman Hattersley 1969, Nibco T-585-70, Toyo 5044A, Victaulic 722.

.2 NPS 2 and under, soldered:

.1 Forged brass body, threaded cap, chrome plated ball, PTFE seats.

.2 Ball valves for isolation service shall have a large/full port.

.3 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.

.4 Acceptable Products:

.1 Class 500 W.O.G. [3450 kPa] - Crane F9222, Grinnell 3700SJ, Kitz 59, Newman Hattersley 1979, Nibco S-585-70, Toyo 5049A.

2.13 BALANCE FITTINGS AND VALVES

.1 NPS 1-1/4 and under:

.1 Bronze body and bronze trim, rising stem, renewable composition disc, globe type with memory stop, Lockshield, male union connection, angle and straight type.

.2 Acceptable Products:

.1 Class 100 [690 kPa] - Dahl 13000-M series, Toyo 250 or 251.

.2 NPS 1-1/2 and over:

.1 Screwed connections up to NPS 2.

.2 Flanged connections NPS 2-1/2 and over.

.3 Cast iron body, non-lubricated eccentric plug with resilient coating EPT or RS 55, suitable for 121°C [250°F] operating temperature, stainless steel bearings, adjustable memory stop, plug type suitable for wrench adjustment.

.4 Acceptable Products:

.1 Class 175 W.O.G. [1210 kPa] - DeZurik 400, Keystone Ballcentric.

2.14 SWING CHECK VALVES

.1 NPS 2 and under, screwed:

.1 Bronze body, bronze swing disc, screw in cap, regrindable seat.

.2 Acceptable Products:

.1 Class 125 [860 kPa] - Crane 1707, Grinnell 3300, Kitz 22, Newman Hattersley 60, Nibco T-413-B, Toyo 236.

.2 NPS 2 and under, soldered:

.1 Bronze body, bronze swing disc, screw in cap, regrindable.

.2 Acceptable Products:

.1 Class 200 W.O.G. [1380 kPa] - Crane 1707S, Grinnell 3300SJ, Kitz 23, Newman Hattersley 61, Nibco S-413-B, Toyo 237.

.3 NPS 2-1/2 and over, flanged:

.1 Cast iron body, renewable or regrindable seat, bronze swing disc, bolted cap.

.2 Acceptable Products:

.1 Class 125 [860 kPa] - Crane 373, Grinnell 6300A, Kitz 78, Newman Hattersley 731, Nibco F-918, Toyo 435A.

2.15 SILENT CHECK VALVES (SPRING TYPE)

.1 NPS 2 and under, screwed:

.1 Bronze body, bronze trim, stainless steel spring, (heavy duty spring in vertical down flow application).

.2 Acceptable Products:

.1 Class 125 [860 kPa] – Conbraco 61-500, Durabla, Grinnell 3600, Muessco 203BP.

.2 NPS 2-1/2 and over:

.1 Cast steel, wafer style, bronze trim, stainless steel spring (heavy duty spring in vertical down flow application).

.2 Acceptable Products:

.1 Class 125 [860 kPa] - Apco, Centerline, Durabla, Duo-Chek II, Grinnell CV817, Nibco W-910, M & G.

2.16 NEEDLE VALVES

.1 Bronze body, screwed, globe type with cadmium plated steel stem.

.2 Acceptable Products:

.1 Class 400 [2760 kPa] - Crane 88/89, RP&C 60-100.

.3 Application: Install needle valves where petcocks or manual vents are indicated.

2.17 RADIATOR VALVES

.1 Screwed bronze body with bronze trim, wheel handle, rising stem, renewable composition disc, male union connections, angle and straight type.

.2 Acceptable Products:

.1 Class 100 [690 kPa] - Dahl 11041 or 11042, Dunham Bush 200B or 246B, Kitz 100 series, Sarco type R or RP, Toyo 252 or 253.

2.18 THERMOSTATIC RADIATOR VALVES

.1 Screwed nickel plated brass body, stainless steel spindle, EPDM rubber valve disc, straight and angle type.

.2 Valves complete with sensors, operators and capillary tubing.

.3 Remote sensors/operators to have 8 m [26 ft] capillary tube.

.4 Capillary tubing to be run concealed in walls and ceilings, sheathed in 20 mm [3/4"] dia. plastic tubing.

.5 Acceptable Products: Danfoss

.6 Notes:

.1 Valves in public areas to have valve mounted operators with remote wall mounted sensors.

.2 Valves on convector units to have valve mounted operators and sensors.

2.19 DRAIN VALVES

.1 Globe type, bronze body with bronze trim and composition disc.

.2 Acceptable Products:

.1 Crane 1703, Dahl 2343, Kitz 03, Newman Hattersley 13, Nibco T-235-Y, Toyo 220.

Part 3 Execution

3.1 PIPING

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

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

.3 Install piping to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.

.4 Maintain a minimum of 25 mm [1"] space between adjacent flanges or pipe insulation, whichever has the larger diameter.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.6 Saddle type branch fittings may be used on mains, if branch line is half size or smaller than main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Use long radius elbows.

.8 Install all thermometer wells and immersion sensor wells specified under Section 15900. Where wells will restrict flow in small diameter pipes (NPS 1-1/2 and smaller) install a section of oversized pipe at least NPS 2.

.9 Screw or weld (unless otherwise specified) all piping systems up to NPS 2.

.10 Weld (unless otherwise specified) all piping systems NPS 2-1/2 and over.

.11 Remake leaking joints using new materials, do not caulk or cement leaking threaded joints.

.12 Use eccentric reducers at pipe size changes, flush on top side, to permit positive venting and drainage.

.13 Do not use thread protection couplings, close nipples, running nipples or street elbows.

.14 Install dielectric type unions or flanges on "OPEN" type systems, where copper piping connects to steel. eg. domestic hot water tanks.

3.2 PIPE GRADING

.1 Grade all piping to provide positive drainage and venting. Slope as follows:

.1 Supply mains and branches - up in the direction of flow, minimum 1:480 [1" in 40 ft].

.2 Return mains and branches - down in the direction of flow, minimum 1:480 [1" in 40 ft].

.3 Reverse return supply and return mains - up in the direction of flow, minimum 1:480 [1" in 40 ft.].

3.3 SOLDERING AND BRAZING

.1 Pressure fluid systems - with chemical treatment (heating) BRAZE with silver base brazing alloy, 538°C [1000°F] melting point.

.2 Pressure fluid systems - without chemical treatment, (domestic water) SOLDER with 95/5 tin-antimony.

.3 Non-pressure systems, (drains) SOLDER with 50/50 tin lead.

.4 Piping connections to radiant ceiling panels, SOLDER with 95/5 tin-antimony.

3.4 DRAIN CONNECTIONS

.1 Pipe the discharge from all liquid relief valves, liquid safety valves, high capacity air vents, steam drip pan elbows, equipment blowdowns, water columns, overflows and piping system drains to the nearest building drain. Install a brass, bronze or copper receiving funnel on the drain where shown.

.2 Drains from drain pans shall be DWV copper ASTM B306 32 mm [1-1/4"] minimum size.

.3 Drain and vent piping shall be of the same material as the piping system to which it is connected, except where otherwise specified.

3.5 EXPANSION OF PIPING

.1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to equipment and building.

.2 Only major expansion configuration and fittings have been shown on the drawings. Provide all required additional compensators, loops and swing connections.

.3 Provide anchors, where shown. Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.

.4 Expansion loops shall be of all welded construction with long radius elbows.

.5 Install expansion loops, cold sprung 50% of the calculated expansion.

.6 Install at least three [3] elbows in all branch connections. Where space does not permit 3 elbows, install braided flexible pipe connectors in accordance with manufacturers recommendations. Three [3] elbow branch connections shall have sufficient developed length to ensure that excessive stresses are not generated in the piping and in no case less than 900 mm [36"].

3.6 VALVES

.1 Install valves with stems upright or angled 45° above horizontal unless approved otherwise.

.2 Install control valves with their stems upright unless approved otherwise and with adequate clearance for removal of actuators.

.3 Use gate valves or (ball valves NPS 2 and under) to shut off branch takeoffs and to isolate equipment.

.4 Use globe valves to control flow in circuits; except, where balancing cocks are specifically specified.

.5 Use plug type globe valves in control valve bypass connections.

.6 Use plug cocks for balance valves in water return branch mains and branch connections to return mains and for shut off and balancing on glycol circuits.

.7 Install balance fittings or valves in the return piping connections to each terminal heating unit - eg. radiators, unit heaters, fan coil units, heating coils.

.8 Install radiator valves in the supply connections to each convection heating element.

.9 Use swing check valves, in horizontal and vertical upflow pipes and on the discharge of pumps.

.10 Use silent check valves where specifically shown in vertical pipes with downward flow.

3.7 DRAIN VALVES AND HOSE BIBBS

.1 Install drain valves and hose bibbs at each low point in the piping system and at specific drain locations shown on the drawings.

.2 Install NPS 3/4 hose bibbs at all downfed terminal heating and/or cooling units.

.3 Install NPS 1-1/2 or NPS 3/4 on line sizes less than NPS 1-1/2 drain valves / hose bibbs at all low points in the piping systems to facilitate draining.

.4 Install drain valves in lieu of hose bibbs for systems operating at over $93^{O}C$ [$200^{O}F$].

.5 Install a hose end adaptor on the discharge side of each drain valve or pipe to drain, where indicated.

.6 Use a NPS 1-1/2 firehose and connect it to the discharge side of the drain valves, to flush the piping system during the pipe cleaning process.

.7 Install caps, with chains, on hose end adaptors, in public areas.

3.8 PIPING TESTS

.1 Notify the Departmental Representative and the Inspection Authority having jurisdiction, 48 hours in advance of intended test dates.

.2 Before testing piping, isolate all equipment which cannot withstand the test pressure.

.3 Do not insulate, backfill or conceal until tests have been completed and approved by the inspection authorities.

.4 Examine all systems under test for leaks.

.5 Joints shall remain dry during the test. A general sweating around a weld shall be reason for rejection.

.6 Remake all leaking connections and joints.

.7 Tests shall be limited to new piping only.

.8 Initial Hydrostatic test:

.1 150% of working pressure, but not less than 860 kPa [125 psig] for 1 working day.

.9 Final Hydrostatic test:

.1 150% of working pressure, after piping connections to all equipment are complete, maintain until all parts of piping systems have been inspected.

3.9 FLUSHING AND CLEANING

.1 Flushing and cleaning shall commence only after all piping tests have been completed.

.2 Install temporary bypass connections around all heat pump units before commencing chemical cleaning.

.3 Chemically clean the following piping systems as recommended by an approved professional chemical cleaning and treatment agency who shall supervise the work:

.1 Heating hot water system(s), heat pump hot and chilled water loop.

.4 Flush out all traces of chemicals with clean water after chemical cleaning is complete.

.5 Remove, clean and reinstall all strainer baskets.

.6 Submit a report signed by a principal of the Agency which certifies that the cleaning has been satisfactorily completed.

3.10 CHEMICAL TREATMENT

.1 Chemically treat water systems in accordance with Section 23 25 00.

3.11 TESTING AND BALANCING

.1 Balance all piping systems in accordance with the requirements of Section 23 05 93.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This section of the specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REFERENCE STANDARDS

.1 The provision of all specialty components shall be in accordance with ANSI/ASME B31 Codes for Building Services Piping.

1.3 REGULATORY REQUIREMENTS

.1 All water specialty components shall be provided in compliance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

1.4 SYSTEM PRESSURE RATINGS

.1 Piping systems 860 kPa [125 psig] or less operating pressure - 860 kPa [125 psig] rating.

Part 2 Products

2.1 AIR VENTS AUTOMATIC - HIGH CAPACITY TYPE

.1 Non-Serviceable Type

.1 Casing and internal parts suitable for system operating pressure and temperature.

.2 All metal construction with outlet threaded to accept vent tubing connection.

.3 Automatic float type.

.4 Shrader type venting valve.

.5 Acceptable Products:

.1 1035 kPa [150 psig] maximum operating pressure -Armstrong 11-AV, Maid-O-Mist 71, Taco 426, Watson McDaniel AE1800.

.2 Serviceable Type:

.1 Casing and internal parts suitable for system operating pressure and temperature.

.2 Automatic float type.

.3 Replaceable float, linkage, plug and seat.

.4 Acceptable Products:

.1 1035 kPa [150 psig] maximum operating pressure -Armstrong 1-AV, Maid-O-Mist 71, Sarco 13W, Watson McDaniel AE1800R.

2.2 AIR VENTS MANUAL - HIGH CAPACITY

.1 Globe Type

.1 Bronze body, union bonnet, screwed, 450 brinell hardened stainless steel trim and plug type disc.

.2 Acceptable Products:

.1 Class 125 [860 kPa] - Crane 14-1/2 LP, Jenkins 2032, Lunkenheimer 73-PS, Toyo 214.

2.3 AIR VENTS MANUAL - RADIATOR TYPE

.1 Needle Type

.1 Bronze or steel body, screwed, needle valve.

.2 Manual key operator.

.3 860 kPa [125 psig] maximum operating pressure and 121°C [250°F] maximum operating temperature.

.4 Acceptable Products:

.1 Maid-O-Mist 816.

.2 Hydroscopic Type

.1 Bronze or steel body, screwed, hydroscopic discs.

.2 Manual screwdriver or key operator.

.3 Acceptable Products:

.1 345 kPa [50 psig] maximum operating pressure - Dunham Bush V19B, Maid-O-Mist 72, Taco 417.

.2 517 kPa [75 psig] maximum operating pressure -Maid-O-Mist 72, Taco 417.

2.4 COMBINATION BALANCE/CHECK VALVES

.1 Integrated shut off, non-slam check valve and balance valve.

.2 Suitable for 1029 kPa [150 psig] and 122°C [250°C].

.3 Cast iron body, stainless steel trim, bronze seat and disc.

.4 Connections:

.1 NPS 2" [50mm] and under; screwed.

.2 NPS 2½" [63mm] and over; flanged.

.5 Select for system flow rate, and allowable pressure drop at a velocity not exceeding 1.8 m/s (6 fps).

.6 Acceptable Products:

.1 Armstrong Flo Trex, Bell & Gossett Triple Duty, Taco Multi-purpose, Victaulic triple service valves.

2.5 EXPANSION JOINTS

.1 Copper Pipe Expansion Compensator - Low Pressure

.1 Bronze or stainless steel convoluted bellows.

.2 Suitable for up to 414 kPa [60 psig] working pressures.

.3 20 mm [3/4"] to 32 mm [1-1/4"] diameter, suitable for 12 mm [1/2"] compression and 6 mm [1/4"] extension.

.2 Steel Pipe Expansion Compensator

.1 Factory assembled unit, with stainless steel or phosphor bronze bellows in carbon steel casing.

.2 Anti-torque groove in casing, internal pipe guide at both ends, full length internal liner.

.3 Suitable for 1035 kPa [150 psig] operating pressure.

.4 Suitable for 38 mm [1-1/2"] compression and 6 mm [1/4"] extension.

.5 Acceptable Products:

.1 Adsco, Flexonics, Flextech Industries, Hydroflex, Metraflex, Vibra-Flo.

2.6 EXPANSION TANKS - DIAPHRAGM TYPE

.1 Expansion tanks with a working pressure exceeding 207 kPa [30 psig] or with a diameter exceeding 610 mm [24"].

.1 Steel construction with sealed-in elastomer diaphragm suitable for up to 116°C [240°F].

.2 Manufactured in accordance with the requirements of ASME Section VIII, Pressure Vessels, Division 1, 860 kPa [125 psig] pressure rated.

.3 Identification plate showing:

.1 Manufacturer's name.

.2 Capacity in litres.

.3 Hydraulic test pressure.

.4 Working pressure.

.5 Code stamping and ASME registered design.

.4 Air precharged via air charging valve to a pressure of 83 kPa [12 psig].

.5 Saddles for horizontal installation or base mount for vertical installation.

2.7 FLEXIBLE HOSES - BRAIDED

.1 Phosphor bronze convoluted bellows with braided bronze sleeve or stainless steel convoluted bellows with braided stainless steel sleeve.

.2 Suitable for system operating temperature and pressure.

.3 Connections:

.1 NPS 2" [[50mm]] and under, screwed connections.

.2 NPS 2½" [63mm] and over, flanged connections.

.4 Length shall be as recommended by manufacturer, unless noted otherwise.

.5 Acceptable Products:

.1 Flexonics Flex Con, Flextech Industries, Hydro Flex, Keflex, Vibra-Flo.

2.8 FLEXIBLE PIPE CONNECTORS

.1 Flexible pipe connectors complete with control rods, manufactured from polyester tire cords and bridge bearing quality neoprene or EPDM; cover and liner to CSA Standard CAN3-S6-M88, Section 11.5.8.3. Provide flanges, bolts, etc. for outdoor installation. Do not make attachments between equipment and piping other than on equipment side of flexible connector.

.2 Twin sphere design with reinforcing ring.

.3 Safety factor for burst and flange pullout shall be a minimum of 3:1.

.4 Acceptable Products:

.1 Mason Safeflex SFDEJ c/w Mason CR control rods, Flextech Industries.

2.9 FLOW CONTROL VALVES - AUTOMATIC

.1 Body and internal parts suitable for maximum system temperature and pressure.

.2 Body fitted with inlet and outlet measuring connections.

.3 Devices shall automatically control the required flow quantity between differential pressure ranges of:

.1 7 to 96 kPa [1 to 14 psig].

.2 14 to 220 kPa [2 to 32 psig].

.3 27 to 390 kPa [4 to 57 psig].

.4 Provide a dual hose temperature/pressure meter kit with flow conversion chart and carrying case.

.5 Acceptable Product:

.1 Griswold.

2.10 CIRCUIT BALANCING VALVES

.1 NPS 2" [[50mm]] and under: copper alloy body, screwed, 'Y' pattern globe.

.2 NPS 2½" [63mm] and over: cast iron body, flanged or grooved, 'Y' pattern globe.

.3 Maximum pressure 1715 kPa [250 psig] and maximum temperature 121°C [250°F].

.4 Calibrated balancing valve with memory, positive shut-off, inlet and outlet pressure measuring connections with integral shut-offs and drains.

.5 Calibration charts and adjustment tools to be included.

.6 Provide one (1) differential pressure meter kit suitable for direct readout c/w connection hoses suitable for the system pressure.

.7 Acceptable Products:

.1 Bell and Gossett - Circuit Setter

.2 ESBE - Circuit Setter

.3 Tour & Anderssen - STAD

.4 Armstrong - CBV

.5 Wheatley - GS

2.11 FLOW MEASURE DEVICES - LIQUID

.1 Flow measuring device, to be sized to provide a readout signal between 2488 and 9954 Pa [10" to 40" W.G.].

.2 Where the required minimum straight pipe lengths cannot be provided for in-line devices, use elbow or venturi type devices.

.3 Each element shall be complete with instrument shut-off valves with finger tight connections and identification tag and chain.

.4 Each element shall be c/w a chained metal tag showing element size, location, volume, and differential signal.

.5 Acceptable Products:

.1 Elbow Type - Measurell.

.1 NPS 2" [[50mm]] and under: cast bronze elbow, screwed ends, 860 kPa [125 psig].

.2 NPS 2½" [63mm] and over: steel elbow, welded ends, 860 kPa [125 psig].

.3 Schedule 40: all fluids closed circuit.

.4 Schedule 80: on open circuits.

.2 In-line type - Verabar, Accutube, Flo-Probe, Preso, Valitube.

.1 NPS 1-1/2 and under: Verabar, Model C050 series, Schedule 40 pipe nipple with factory installed sensing probe.

.2 NPS 2" [[50mm]] and over: Verabar, Model C100 series, standard insert sensor with 12 mm [1/2"] threaded weld coupling.

.3 Venturi type - Gerand, Preso.

.1 NPS 2" [[50mm]] and under: brass screwed.

.2 NPS 2½" [63mm] and over: cast iron or steel, flanged, butt welded or roll grooved couplings where permitted.

.6 Provide a direct readout dial type meter complete with connecting hoses, and calibration charts to read the measured flow. Flow meter shall be calibrated in Pascals or mm of water column [inches of water] and shall be suitable for water/glycol.

.1 Acceptable Products:

.1 Eagle Eye, Gerand, Preso, Western Meter Model SCL101.

2.12 PRESSURE RELIEF VALVES - WATER

.1 Screwed, bronze body or cast iron body with expanded outlet.

.2 ASME rated.

.3 Coordinate with Heat Exchangers Schedules.

.4 Acceptable Products:

.1 Bronze body: Watts 174A, NPS 3/4 to NPS 2" [[50mm]].

.2 Iron body: Watts 740, NPS 3/4 x 1 to NPS 2" [[50mm]] x 2-1/2.

2.13 STRAINERS

.1 NPS 2" [[50mm]] and under: bronze body, screwed connections.

.2 NPS 2½" [63mm] and over: cast iron body, flanged connections.

.3 NPS 2" [[50mm]] and over: Y or T type strainer with grooved ends with ductile iron body or malleable iron body.

.4 Suitable for maximum system operating pressure.

.5 Basket Screen:

.1 Bronze, stainless steel or monel perforated screen.

.2 35 holes/cm^2, 1.2 mm dia. perforations, 36% open area.

.6 Acceptable Products:

.1 Armstrong, Erwel, Kitz, Mech-Line, Muesco, Spirax/Sarco, Toyo, Victaulic.

2.14 SUCTION GUIDE

.1 Integrated long radius elbow, strainer and suction entrance guide vanes.

.2 Suitable for 1029 kPa [150 psig] and 122°C [250°F].

.3 Cast ductile iron body, stainless steel strainer, steel guide vanes.

.4 Connections:

.1 NPS 2" [[50mm]] and under, screwed.

.2 NPS 2½" [63mm] and over, flanged.

.5 Select for system flow rate and allowable pressure drop.

.6 Acceptable Products:

.1 Armstrong Suction Guide, Bell & Gossett Suction Diffusers, Mech-Line, Taco Suction Diffuser, Victaulic suction diffuser.

2.15 TEST PLUGS FOR PRESSURE / TEMPERATURE

.1 Provide 6mm [1/4"] NPT solid brass test plug fitting c/w brass chain where indicated.

.2 Test plugs shall be capable of receiving either a pressure or temperature 3mm [1/8"] O.D. Dual seal core shall be Nordel suitable for temperature of 177°C [350°F] and shall be rated zero leakage from vacuum to 6895kPa [1000psi).

.3 Provide 1 master test kit containing 2 - test pressure gauge of suitable range, 1 gauge adaptor 3mm [1/8"] O.D. probe and 2 - stem pocket testing thermometers of suitable range.

.4 Acceptable Products:

.1 Sisco P/T Plugs.

.2 Flow Design - Superseal.

Part 3 Execution

3.1 AIR VENTS - AUTOMATIC - HIGH CAPACITY TYPE

.1 Install automatic high capacity air vents at each high point in the piping systems and where shown on the drawings.

.2 Install on tees and not on horizontal pipe runs or elbows.

.3 Install a 12 mm (1/2") minimum isolating gate valve ahead of each air vent, unless air vent has an integral shut-off valve.

.4 Fit all vents on top of an air collecting chamber.

.5 Pipe all air vent discharge connections, (except for glycol) separately, to the nearest building drain, using 6 mm (1/4") hard drawn copper tube. Label ends with permanent labels.

.6 Pipe all air vent discharge connections, (except for glycol) separately, to a water-tight solder jointed, 1.2 mm (16 ga.) copper drain pan, using 6 mm (1/4") hard drawn copper tube where exposed and soft copper where concealed. Label ends with permanent labels.

3.2 AIR VENTS - MANUAL - HIGH CAPACITY

.1 Install manual air vents at high points in the piping systems where shown on the drawings.

.2 Install on tees and not on horizontal pipe runs or elbows.

.3 Install isolating gate valve ahead of each vent valve.

.4 Pipe air vent discharge connections to nearest building drain.

.5 When using needle valves, run 6 mm (1/4") vent line down to needle valve at low level, complete with nipple and cap.

3.3 AIR VENTS MANUAL RADIATOR TYPE

.1 Install manual/automatic low capacity air vents on the return side of each water heating/cooling terminal element installed above the connection mains piping.

.2 Fit air vent on top of an air collecting chamber of NPS 3/4 pipe, 150 mm (6") high.

.3 Arrange air vents so that screwdriver slots or key openings are easily accessible.

.4 Drill access holes through radiation enclosures, where necessary.

.5 DO NOT USE on glycol systems.

3.4 COMBINATION BALANCE/CHECK VALVES

.1 Install combination stop/balance/check valves on the discharge of centrifugal pumps where shown on the drawings and/or where scheduled.

.2 Install in accordance with the manufacturer's recommendations.

.3 Minimum 5 pipe diameters from pump connections.

3.5 EXPANSION JOINTS

.1 Install expansion compensators at each location shown on the drawings.

.2 DO NOT test piping at higher pressures than the working pressure of the compensators.

.3 Take care to be aware of the temperature at which the expansion compensator is installed to properly establish the length.

3.6 EXPANSION TANK - DIAPHRAGM TYPE

.1 Install expansion/contraction tanks at each location shown on the drawings and as scheduled.

.2 Install a gate valve in the system connection.

.3 Install a globe valve in the tank drain connection.

3.7 FLEXIBLE HOSES - BRAIDED

.1 Install braided flexible hoses where shown on the drawings and as the flexible connections to designated heating/cooling terminal units.

.2 On screwed connections, install a union on one end.

.3 Take care not to torque the hose.

.4 Ensure braided flexible hoses are not damaged during hydrostatic testing.

3.8 FLEXIBLE PIPE CONNECTORS

.1 Install convoluted and arched pipe connectors, for misalignment connections, where shown on the drawings.

.2 Install in accordance with manufacturer's recommendations.

3.9 FLOW CONTROL VALVES - AUTOMATIC

.1 Install automatic flow control valves where shown on the drawings in accordance with the manufacturer's instructions.

.2 Hand over temperature/pressure meter kit and calibration charts to the Owner's representative, at substantial performance and obtain receipt.

3.10 CIRCUIT BALANCING VALVES

.1 Install flow measuring balancing valves where shown on the drawings in accordance with the manufacturer's instructions.

.2 Hand over differential pressure meter kit and calibration charts to the Owner's representative, at substantial performance and obtain receipt.

3.11 FLOW MEASURING DEVICES - LIQUID

.1 Install the flow measuring devices in the piping circuits to establish the operational flow rates. Measuring devices shall be located where shown on the drawings.

.2 Install in accordance with the manufacturer's installation instructions and in the correct size of pipe. Reduce pipe size as required. Particular attention to be paid to required upstream and downstream straight pipe lengths.

.3 Install isolating globe, ball or needle valves with 6 mm (1/4") male end SAE flare connection on pressure tapping connections.

3.12 PRESSURE RELIEF VALVES - WATER

.1 Install pressure relief valve(s) on each heat exchanger to prevent over pressuring.

.2 Select relief valves to relieve full heat input of the heat supply side.

.3 Pipe relief valve to drain.

3.13 STRAINERS

.1 Install pipe line strainers where shown on the drawings.

.2 Provide isolation valves on either side of the strainer to permit cleaning without draining the system.

.3 Blowdown connections:

.1 Strainers, NPS 2" [[50mm]] and under - hot services: nipple and cap.

.2 Strainers, NPS 2½" [63mm] and over - hot services: nipple, globe valve and nipple.

.3 Strainers, all sizes - cold services: plug.

3.14 SUCTION GUIDE

.1 Install suction guides on the suction of centrifugal pumps, where shown on the drawing and where scheduled in accordance with manufacturer's recommendations.

.2 "Start up" strainer baskets must be removed prior to commissioning of systems.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 23 05 00.

.2 Submit shop drawings of pump curves with operating points indicated.

.3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.

.4 Submit motor efficiencies for all motors 1H.P. and over. Refer to Section 23 05 00 for minimum efficiencies.

1.3 GENERAL

.1 Motors powered by variable speed drive controllers shall be EEMAC Class B with Type F insulation, shall have a 1.15 service factor and shall be suitable to be driven by PWM variable speed drive controllers. The motor manufacturer shall submit in writing confirmation that the motors are designed to withstand voltage peaks of 1400 volts and a voltage rate of rise of 2000 volts / microsecond at a frequency of 20 kHz.

Part 2 Products

2.1 IN-LINE CIRCULATOR PUMPS

.1 Suitable for a maximum working pressure of 860 kPa [125 psig] and maximum temperature of 107°C [225°F].

.2 Casing: Cast iron radially split, with flanged connections. Supplied with matching companion flanges.

.3 Impellor: Corrosion resistant cadmium plated steel.

.4 Shaft: Alloy steel with bronze sleeve bearing, integral thrust collar.

.5 Seal Assembly: Mechanical.

.6 Coupling: Flexible self-aligning.

.7 Motor: Resilient mounted, drip proof, sleeve bearing.

2.2 VERTICAL IN-LINE CENTRIFUGAL PUMPS

.1 Suitable for a maximum working pressure of 1210 kPa [175 psig] and maximum temperature of 107°C [225°F].

.2 Casing: Cast iron radially split, single stage, flanged suction and discharge connections, separate tapped openings for venting, draining and gauge connections.

.3 Impellor: Bronze dynamically balanced, keyed drive with locking nut.

.4 Shaft: Stainless steel on split coupled pumps and carbon steel with bronze sleeve on close coupled pumps.

.5 Seal Assembly: Inside unbalanced mechanical seal with factory installed seal flushing line.

.6 Coupling: Close coupled on motors less than 7-1/2 HP and split couplers for all motors 7-1/2 HP and larger to permit removal of seal without disturbing the motor.

.7 Motor: EEMAC Class B, squirrel cage induction, continuous duty, drip proof, ball bearings.

.8 Accessories: Strainer/suction guide, combination check/balance valve where scheduled.

Part 3 Execution

3.1 INSTALLATION

.1 In-line Circulators:

.1 Install as indicated by flow arrows.

.2 Support at flanges on outlets of unit.

.3 Install with bearing lubrication points accessible.

.2 General:

.1 Ensure that pumps are installed and aligned such that no piping or equipment loads are imposed on the pump body. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.2 Check pump rotation.

.3 Pipe drain tapping to floor drain.

.4 "Start-up" strainer baskets in strainer/suction guides must be removed prior to commissioning of systems.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 All sections of Division 23 Specifications form part of Contract Documents and are to be read, interpreted and coordinated with all pages. Conform to General Conditions and Division; Instructions to Bidders, Contract General Conditions and Supplements thereto form part of this Division and contain items related to mechanical work.

1.2 SCOPE

.1 Provide for cleaning and degreasing of all systems that use water as a heat transfer medium. (hot water loops)

.2 Provide for cleaning and disinfection of domestic hot and cold systems.

.3 Provide all temporary strainers, connections and by-pass lines as required.

.4 Provide equipment to add chemicals to the systems as specified herein.

.5 Provide equipment to operate and control the system as specified herein. Provide appropriate protection so that capped off unused piping does not corrode.

.6 Provide corrosion coupons for all closed and open loop circulation systems as specified herein.

.7 Piping systems to be chemically treated include the following new systems:

.1 Hot water heating system.

1.3 QUALITY ASSURANCE

.1 The water treatment chemicals and treatment process shall be supplied and performed by the Contractor. This work shall be supervised by the Water Treatment Specialist who, upon completion shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.

.2 Notify Consultant 48 hours prior to chemical cleaning so that work may be verified and inspected.

1.4 REFERENCE STANDARDS

.1 Do HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of regulating authorities, except where specified otherwise.

1.5 SUBMITTALS

.1 Submit shop drawings including proposed chemicals, quantities, calculations, procedures and equipment to be supplied. Provide written operating instructions and system schematics.

.2 Provide written report containing log and procedure of system cleaning, giving times, dates, problems encountered and condition of water.

.3 Submit written report containing test results and list of chemicals added every 14 days from time of commissioning to acceptance.

.4 Provide monthly visits to check chemical treatment, take water samples and recommend any necessary changes to treatment. Provide written report.

1.6 WATER TREATMENT SERVICE

.1 The Water Treatment Specialist shall provide supervision of installations, set-up and adjustments and shall submit a written report on system operations.

.2 All chemicals, feed systems and test equipment shall be provided by the Water Treatment Specialist.

.3 Treatment chemicals shall not contain hydrazene.

.4 Treatment chemicals shall be non-foaming.

.5 The Water Treatment Specialist shall instruct the maintenance personnel before substantial completion. Written instructions of the treatment, dosages control charts and test procedures shall be included in the maintenance manuals.

.6 The Water Treatment Specialist shall provide monthly visits to check chemical treatment, take water samples and recommend any necessary changes to treatment, and provide a written report for a period of one year after substantial completion. Provide sufficient chemicals to treat the system from the time of commissioning to acceptance of the building. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation. The minimum amount of chemicals provided shall include the following:

.1 One spare drum (200L) of chemicals for each open system requiring treatment.

.2 One spare pail (20L) of biocide for each open system requiring treatment.

.3 One spare pail (20L) of chemicals for each closed system requiring treatment.

.7 Provide a test kit suitable for all chemical treatments used. The test kit shall be made available for on-site tests and provide a Myron 3 range TDS meter to check conductivity. Hand over the kit to the Building Operator at project completion - obtain receipt.

.8 Provide one mild steel and one copper corrosion coupon package to monitor corrosion rate for each open and closed systems.

Part 2 Products

2.1 MATERIALS

.1 System Cleaner: Use a Sodium Metasilicate, Sodium Nitrite and a wetting agent compound which in solution removes grease and petroleum products. Concentration level to be determined by Water Treatment Specialist. (PACE Chemicals Ltd. - PURGEX L-24 or approved equal)

.2 Closed System Treatment (Hot Water): Use an all-organic based corrosion inhibitor. Maintain levels at 60 to 100 ppm. (PACE Chemicals Ltd. - BAR COR CWS-105 or approved equal.) Note: The use of Nitrite only, Molybdate only or Sulphite only will not be accepted.

.3 Provide sufficient chemicals to treat the system from the time of commissioning to acceptance of the building. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation.

.4 Materials which may contact finished areas must be colourless.

2.2 EQUIPMENT

.1 Closed System (Heating or Cooling)

.1 Bypass Pot Feeder: All closed hot water systems shall have a by-pass chemical pot feeder with a 7.6 litre capacity. It shall be constructed of heavy duty cast iron or welded steel (suitable for 1380 kPa [200 psi] working pressure), with quick opening cap and complete with 20 mm NPT connections. Isolating valves shall be installed on the inlet, outlet and drain.

.2 Sidestream Filter: All closed hot water systems shall have a sidestream filter housing of steel construction using a 250 mm x 30 micron filter cartridge, with a minimum flow rate of 35 litres/minute. A Flow Indicator shall be installed in conjunction with the sidestream filter. Connections shall be 20 mm MxFNPT and all isolating valves shall be installed as per manufacturer's instructions. Include 6 filter cartridges.

.3 Totalizing Make-up Water Meter: Cast Bronze body, 20 mm NPT connections, thermoplastic rotor and gear train, rated at 1034 kPa [150 psi] maximum operating pressure.

.4 Chemical Feed Piping:

.1 Schedule 40 black steel

.5 Corrosion Coupon and Holder Assembly:

.1 Mild steel corrosion coupon.

.2 Holder, 20 mm or 25 mm NPT male connection.

.3 Provide malleable or cast iron cross, 20 mm or 25 mm NPT female connection.

.2 TEST KITS:

.1 Provide test kits to determine proper systems treatment, including but not limited to the following:

Part 3 Execution

3.1 PRE-OPERATIONAL CLEANING AND CHEMICAL TREATMENT

.1 All systems must be chemically cleaned and flushed before water treatment is added. This includes partial or complete filling for pressure testing.

.2 Provide drain connections to drain system in one hour.

.3 All drains for chemical treatment shall be piped to the sanitary sewer.

.4 Install totalizing water meter(s) and record capacity in each system.

.5 After all components of the piping system have been pressure tested and proven to be in full operational condition and leak free, flush entire system with fresh, clean make-up water to remove loose mill scale, sediment and construction debris.

.6 After initial flushing has been completed, clean all strainer screens.

.7 System pumps may be used for cleaning, provided that pumps are dismantled and inspected, worn parts repaired with new gaskets and seals installed. Submit used seals.

.8 Add cleaner to closed systems at concentration levels recommended by the Water Treatment Specialist.

.9 For hot water heating systems, apply heat while circulating, raise temperature slowly to 70C and maintain at 70C for minimum of 12 hours. Remove heat and circulate at 40C or less. After cleaning, drain system as rapidly as possible. Flush system by opening drain valves and opening bypass valve on water make-up to system. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Install corrosion coupons, refill system and immediately add water treatment to proper level.

.10 Use neutralizing agents upon recommendation of the Water Treatment Specialist and as approved by Departmental Representative.

.11 Inspect, remove sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

.12 Flush open systems with clean water for minimum of one hour. Drain completely and refill. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Stop flushing. Immediately add corrosion inhibitor and test to ensure proper level.

3.2 CLEANING AND CHLORINATION OF POTABLE WATER PIPING

.1 All domestic water piping shall be thoroughly flushed so that it is free from scale, sediment, construction debris etc.

.2 On completion of installation and testing of the potable water systems, pre-flush, chlorinate with Sodium Hypochlorite to AWWA C651-05 specifications and let stand for 24 hours. Thoroughly flush again until flush water meets AWWA standards.

.3 Retain an independent inspection firm to supervise and inspect the chlorination and flushing procedures and perform chemical tests as required.

.4 Submit to the Departmental Representative, a certificate from the testing firm, stating that the chlorination and flushing have been successfully carried out.

.5 Acceptable Firms: PACE Chemicals Ltd., GE Betz Dearborn.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This section of the specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 CERTIFICATION OF RATINGS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 BREECHING AND CHIMNEYS - ALL FUELS

.1 Minimum Requirements:

.1 Factory-built seismically-rated sectional prefabricated double wall breeching and chimney.

.2 U.L.C. listed.

.3 Venting system is to comply with Category IV (positive exhaust pressure) venting system requirements in accordance with the latest edition of CAN/CSA B-149.1, as well as per boiler manufacturer recommendations.

.2 Accessories:

.1 The entire stack system from each boiler or appliance to the termination shall be from one manufacturer and shall include for all required components necessary such as pipe lengths, adjustable pipe lengths, tees, elbows, ventilated roof thimble, insulated exit cone termination, supports, guides, flanged boiler adaptor, joint sealant, angle rings, drain sections, etc.

Part 3 Execution

3.1 CHIMNEYS

.1 Install in accordance with manufacturers recommendations.

.2 Support chimneys at bottom, roof and intermediate levels as indicated. Install thimbles where penetrating roof, floor, ceiling.

.3 Install chimneys penetrating roofs as indicated, complete with flashings to suit installation.

.4 Install guy wires as necessary.

.5 Exposed metal parts outside building to be painted with heat and corrosion resistant primer and finish paint.

3.2 EXPANSION COMPENSATORS

.1 Install in accordance with the manufacturer's recommendations.

.2 Provide adjacent breeching sections with oversize flanges as required to maintain clear inside breeching diameter through the compensator.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 REFERENCE STANDARDS

.1 Install packaged boiler(s) in accordance with current Regulations of the Province of B.C., CSA B51, ASME Codes, CSA B140.7.2., CAN1-3., Canadian Electric Code, CSA B139, CSA B139S1, CAN1-B149.1, ANSI B31.1, except where specified otherwise.

1.3 SUBMISSIONS

.1 Submit certificate of inspection from B.C. Boiler Pressure Vessel Safety Branch.

Part 2 Products

2.1 GENERAL

.1 Packaged boiler: complete with burner and necessary accessories and controls, and ready for attachment of water supply, return and drain piping, fuel piping, electrical connections, and chimney connection.

.2 Designed and constructed in accordance with ASME Code requirements.

.3 Electrical components CSA approved.

.4 Approved by:

.1 B.C. Boiler Inspection Department

.2 B.C. Gas Inspection Department

.5 Boilers to be test fired before shipment and to be registered with the Provincial Authorities.

.6 Include erection and wiring diagrams and an operating and maintenance manual with boiler package.

.7 Check all available drawings and ensure that the boiler proposed will fit in the space allotted and can be maintained and operated in a normal manner without difficulty.

2.2 BOILERS – HIGH EFFICIENCY

.1 Minimum Requirements:

.1 Provide gas fired hot water boiler, forced draft with insulated jacket, controls and boiler trim.

.2 Must have a steady state combustion efficiency of 91%, verified by ANSIZ21.13 based on return water temperature of 54.4°C [130°F].

.3 Certified with Eco Logo from Environment Canada.

.4 Up to 98% Ultra-high efficiency.

.5 Min 80 PSI working pressure.

.6 Suitable for operation with variable flow.

.2 Construction:

.1 Assembly conforming to ASME Code requirements and tests for maximum working pressure of 1034 kPa [150 psi] water.

.2 Flue passages shall be chemically highly resistive stainless steel heat exchanger surface and readily accessible without use of special tools.

.3 Stainless steel AL29-4C venting.

.4 Structural steel base with front plate, removable panels and lifting lugs. Provide secure attachment points for seismic anchoring.

.5 Entire boiler insulated with 100 mm [4"] thick glass fiber and finished with steel jacket finished with factory applied baked enamel.

.6 Provide manhole access into boiler as required.

.3 Hot Water Boiler Trim:

.1 Combination water pressure and temperature gauge, and ASME rated pressure relief valves.

.2 Low water cut-off with manual reset and special retard circuit to automatically prevent burner operation when boiler water falls below safe level. "The low water cut off must automatically reset on a resumption of power at the device".

.3 Operating temperature controller shall control burner operation to maintain boiler water temperature. Controller shall be electronic.

.4 Limit temperature controller shall control burner to prevent boiler water temperature from exceeding safe system temperature.

.5 Provide boiler air vent tapping

.6 Provide motorized isolation valves in the return pipe for each boiler.

.7 Provide condensate neutralization tanks.

.4 Burner:

.1 Pre-mix burner technology.

.2 Burner operation shall be modulating with low fire position for ignition, min 10:1 turndown, full modulation.

.3 Forced draft gas burner with electric ignition, equipped with Low-Nox burner technology and gas pressure regulator (2-5 psi inlet pressure).

.4 Pre-wired, factory assembled electronic controls on control cabinet with flame scanner or detector, programm¬ing control, relays and switches. Provide pre-purge and post-purge ignition and shutdown of burner in event of ignition pilot and main flame failure with manual reset.

.5 Double wall Category IV vent for each boiler separately.

.5 Controls:

.1 Mod bus based controls, BACnet interface.

.2 Boiler manufacturer to provide all controls to operate all boiler modules.

.3 Provide signals to BMS on boiler fail or alarms.

.4 Provide signal that boilers are operating.

.5 Start boilers in sequence and provide a lead lag operation.

.6 Control on/off motorized isolation valves.

.6 Standard of Acceptance:

.1 RBI, Fulton Pulse, Viessmann Vertomat, Teledyne Laars HI-E, Hydrotherm Multi-Pulse.

2.3 BOILER CONNECTIONS:

1. Each boiler shall be provided with all necessary inlet and outlet connections. Boiler connections shall be as follows:

.1 One (1) water supply outlet, 2-1/2 " FPT

.2 One (1) water return inlet, 2-1/2" MPT

.3 One (1) relief valve outlet

.4 One (1) flue gas vent outlet, 8" DIA, a 8" x 6" adapter shall be included with the boiler.

.5 One (1) fuel gas inlet, 1-1/2" size, FPT.

.6 One (1) combustion air inlet

2.4 FACTORY TESTING - HYDRONIC

.1 Each factory "packaged" boiler shall be hydrostatically tested. The boiler manufacturer shall perform a hydrostatic test in the presence of an inspector having a National Board Commission. The inspector shall certify a data report which shall be submitted to the engineer as evidence of ASME compliance.

.2 In addition to the ASME symbol, each boiler shall bear a National Board registration number.

Part 3 Execution

3.1 INSTALLATION

.1 Make required piping and electric connections including any control wiring between boiler control panel and oil pump starter.

.2 Pipe relief valves and air vent on hot water boilers to floor drain.

.3 Burner pilot light shall be connected to "uninterruptible" gas supply on dual fuel (oil and gas) boilers.

.4 Do not deviate from required service and maintenance clearances.

.5 Mount unit level.

.6 Natural gas fired installation to CAN1-B149.1-M86.

.7 Oil fired installation to CSA B139, CSA B139S1.

.8 Manufacturer's representative to provide start-up and burner adjustment service and maintenance and operating instructions. Test reports to be submitted for review and inclusion in maintenance manuals.

3.2 BOILER EFFICIENCY TEST

.1 Test boiler in accordance with the ASME short form test procedure after installation and hook up, but before handling units over to the Owner. Forward to the Departmental Representative for his approval all appropriate data and calculations. Make any and all alterations as necessary and repeat the tests as often as required until the test results prove that each unit performs as specified. Make all temporary connections, provide all meters, equipment and instruments, provide all engineering personnel required. Forward three (3) copies of the approved test results to the Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 This section covers items common to Sections of Division 26.This section supplements requirements of Division 01.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-12, Canadian Electrical Code, Part 1 Safety Standard for Electrical Installations.

.2 CSA C22.2 No. 0-10 (R2015), General requirements-Canadian electrical code, part II.

.3 CAN/CSA-C22.3 No. 1-01(Update March 2005), Overhead Systems.

.4 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.1 EEMAC 2Y-1-[1958], Light Gray Colour for Indoor Switch Gear.

.3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

.1 IEEE SP1122-[2000], The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 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.

1.4 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235-83.

.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 for control items in English.

1.5 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials.

.3 Shop drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC Canada.

.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 If changes are required, notify Departmental Representative of these changes before they are made.

.4 Quality Control: in accordance with Section 01 45 00 - Quality Control.

.1 Provide CSA certified equipment and material.

.2 Where CSA certified equipment and material is not available, submit such equipment and material to 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.

.5 Manufacturer's Field Reports: submit to Departmental Representative 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.

1.6 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification].

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.3 Site Meetings:

.1 In accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM). Section 01 32 16.07 - Construction Progress Schedule - Bar (GANTT) Charts.

.2 Site Meetings: as part of Manufacturer's Field Services [described in Part 3 - FIELD QUALITY CONTROL, in appropriate NMS Section, schedule site visits, to review Work, at stages listed.

.1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of Work after cleaning is carried out.

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

1.7 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.8 SYSTEM STARTUP

.1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant will aspects of its care and operation.

1.9 OPERATING INSTRUCTIONS

.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.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

.2 Do verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

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 is not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - 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 Division 23 and as shown on mechanical drawings.

2.4 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of Departmental Representative.

.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 as follows:

.1 Nameplates: Lamicoid 3 mm thick plastic engraving sheet 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

NAMEPLATE SIZES

Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.

.3 Wording on nameplates to be approved by Departmental Representative prior to manufacture.

.4 Allow for minimum of twenty-five (25) letters per nameplate.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and voltage characteristics.

.6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. " as directed by Departmental Representative.

.7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.8 Terminal cabinets and pull boxes: indicate system and voltage.

.9 Transformers: indicate capacity, primary and secondary voltages.

2.7 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, either numbered or 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.

	Prime	**Auxiliary**
up to 250 V	Yellow	
up to 600 V	Yellow	Green
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency	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 to EEMAC 2Y-1-1958.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

.2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

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

3.3 CONDUIT AND CABLE INSTALLATION

.1 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 50mm.

.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.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

.2 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

.4 Locate light switches on latch side of doors.

.1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1400 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: 1400 mm.

.3 Panelboards: as required by Code or as indicated.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.7 FIELD QUALITY CONTROL

.1 Load Balance:

.1 Measure phase current to panelboards with normal loads (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 - 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 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 Systems: fire alarm system and communications.

.6 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.3 Carry out tests in presence of Departmental Representative.

.4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.5 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 General requirements related to existing buildings.

1.2 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results

Part 2 Sequencing, Phasing And Scheduling of Work

.1 Refer to Section 26 05 00 - Electrical Common Work Results and ensure that all work on existing buildings, facilities, services and utilities is coordinated, sequenced, phased, and scheduled with all other work. Refer to specification documents for phasing and scheduling.

Part 3 Existing Conditions

.1 Examine the site and existing conditions prior to tendering on this work and make due allowance for these conditions in the tender. Confirm all locations and routings of any existing services, above and below grade, which might be affected by this installation and allow in the tender for such additional work.

.2 Indication on the drawings of existing conduit, outlets and other electrical apparatus is based on casual field observations and records of past contracts. As such, this information represents the best data available but is not guaranteed to be full or accurate. Verify that field measurements and circuiting diagrams as indicated on Drawings and that abandoned wiring and equipment serve only abandoned facilities. Report discrepancies to Departmental Representative before disturbing existing installation. Disregard types of existing light fixture shown on the demolition drawings, as they represent mosaic of types retrieved from the past projects and observations, and do not relate to the light fixture schedule of the new design. Confirm existing circuiting on site, disregard circuiting shown on demolition drawings, unless verified by Contractor.

.3 Submission of a tender for this work shall indicate that the Contractor has made a thorough examination of the site and has accepted the existing conditions.

.4 Where alterations and/or additions to existing equipment or apparatus are required to be made by these documents, it shall be assumed that any existing CSA certification may be in jeopardy. Ensure that all changes are made in accordance with the current edition of the Canadian Electrical Code, Part 2, obtain re-certification, and include re-certification costs in the tender.

.5 Permit no interruptions to the electric power, fire alarm, telephone, security or other similar systems in the existing building during normal working hours. Advise the Departmental Representative in writing of any intended interruptions outside of these normal hours, including the time and duration of outage. Obtain permission from Departmental Representative at least 24 hours before partially or completely disabling

any of the systems. The Departmental Representative may cancel such permission in emergencies at the last minute without penalty or extra cost. Contractor may be required to work in evenings and weekends as required for the existing main building or to minimize duration of outage with no extra cost to the project.

.6 Assume full responsibility for any disruption to existing services and systems. Provide all necessary material and equipment and provide all labour at no extra cost for any temporary connections be required to maintain services during work in the existing buildings. Include the removal of such temporary connections at completion of the work in the tender price.

.7 Provide new breakers for all additional circuits as required. Update and retype panel schedules. Where existing panels are affected by the scope of work, provide all necessary blank covers and filler pieces: under no circumstances breaker spaces shall be left open.

.8 All systems such as power, lighting, security, CCTV, door control, alarm, sound system, fire alarm system, shall be fully operational during renovation and after renovation and be accepted by the Departmental Representative.

.9 Contractor shall remove all surplus electrical equipment, F.A. devices, speakers, security sensors, wiring, conduits, etc. from renovated areas and return to the Departmental Representative unless otherwise noted.

.10 Contractor shall relocate, rewire or reroute all wiring which passes through renovated areas, or is in line or on the same circuit as the existing device to be removed to ensure continuity of proper operation of all electrical, fire alarm, security systems, etc. in areas which are not renovated, or devices which are to remain operational. Provide blank covers on all removed devices as required.

.11 All equipment shown dotted is existing and shall remain in its present location (unless otherwise noted) or shall be relocated as required as per drawings. Rewire, extend wiring, conduits as required.

.12 Contractor shall allow for adequate removal (without damage) of all fixtures, wiring devices, wires, etc. to facilitate renovation.

.13 Any fixtures, wiring devices, etc. damaged during and after removal shall be replaced with new approved equipment at Contractor's cost.

.14 Contractor is responsible for adequate protection of equipment, furniture, etc. (plastic covers, etc.) during the execution of the work.

.15 Contractor is responsible for cleaning up working area each day before leaving the job site.

.16 Allow for multiple verifications for fire alarm system and other electrical systems dictated by phasing and scheduling as required for partial building occupancy or substantial performance.

Part 4 Installation

.1 Examine drawings of all other trades and allow for all work such as the removal, temporary relocation, and re-installation of electrical fixtures, equipment, devices, wiring, raceways, etc., where such work is required due to alterations in or about existing buildings.

.2 Where work requires modification, extension, and additions to power and low tension services within the existing building, the wiring required for this work shall be installed concealed wherever possible. In certain cases (e.g., where it is necessary to clear obstructions, or to avoid damage to existing structure and/or finish materials), concealed wiring may not be possible. In such cases, special wiring methods such as mineral-insulated cable or wiremold surface mounted raceway, shall be used, provided that, for each specific instance, approval for same is requested from and granted in writing by the Departmental Representative..

.3 Chisel and patch concrete for conduits feeding new pedestal-mounted floor outlets in existing building.

.4 Remove abandoned wiring to source. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

.5 Disconnect abandoned outlets and remove devices. Remove abandoned outlets when servicing conduit is abandoned and removed. Blank off all unused outlet boxes.

.6 Disconnect and remove abandoned panelboards and distribution equipment.

.7 Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

.8 Clean and repair existing materials and equipment which remain or are to be reused, as described elsewhere in these Specifications.

.9 Refer to Division 01, Division 23 and Section 26 05 00 Electrical Common Work Results - Phasing of the Work.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for wire and box connectors.

1.2 RELATED SECTIONS

.1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

- .1 CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
- .2 CSA C22.2No.65-93(R1999), Wire Connectors.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

- .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA)

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.

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

.3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 MATERIALS

.1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors as required.

.2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper 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 Clamp for stranded aluminum conductors.
- .4 Stud clamp bolts.
- .5 Bolts for copper conductors.

.6 Bolts for aluminum conductors.

.7 Sized for conductors as indicated.

.4 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required to: CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors 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 CSA C22.2No.65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

.4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 26 05 34 – Conduit, Conduit fastenings and fittings.

1.2 REFERENCES

.1 CSA C22.2 No.0.3-96, Test Method for Electrical Wires and Cables.

.2 CAN/CSA C22.2 No.131-M89(R1994), Type TECK 90 Cable.

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 by manufacturer of pallets, crates, paddling and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 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 600V insulation of cross-linked thermosetting polyethylene material rated RW90 or RWU90 Jacketed.

.3 Neutral supported cable: 3 phase insulated conductors of Copper and one neutral conductor of Copper steel reinforced, size as indicated.

2.2 TECK 90 CABLE

.1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Conductors:

.1 Grounding conductor: copper as indicated.

.2 Circuit conductors: copper as indicated, size as indicated.

.3 Insulation: Chemically cross-linked thermosetting polyethylene rated type RW90XLPE, 600V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: flat galvanized steel

.6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.

.7 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables.

.3 Threaded rods: 6 mm diameter to support suspended channels.

.8 Connectors:

.1 Watertight, explosion-proof approved for TECK cable.

2.3 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90, 600V XLPE RW90.

.3 Armour: interlocking type fabricated from galvanized steel strip.

.4 Connectors: anti short connectors.

Part 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 Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

.1 Install cable in trenches in accordance with Section 33 71 73.02 - Underground Electrical Service.

.2 Lay cable in cable trays in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.

.3 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.

.2 Perform insulation resistance testing on all cable and wiring, submit results to the department representative.

.3 Perform continuity test on all new cable and wiring; submit results to the department representative.

.4 Check each conductor tested for unintentional grounds.

.5 Check if wire and cable are properly tightened to manufacturer's recommendations.

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

END OF SECTION

PART 1 General

1.1 RELATED WORK

.1 This Section of the Specification is to be read, coordinated and implemented in conjunction with all other parts of the Contract Documents.

1.2 REGULATORY REQUIREMENTS

.1 Restraints shall meet the requirements of the latest edition of the British Columbia Building Code and amendments.

.2 The Seismic Consulting Engineer should be able to provide a proof of professional insurance and the related practice credentials if requested by the Departmental Representative. The Seismic Consulting Engineer should be familiar with SMACNA, ECABC & NFPA guidelines as well as BCBC requirements.

.3 The Contractor's Seismic Consultant shall submit original signed BC Building Code "Letters of Assurance" "Schedules B1, B2, and C-B" to the Departmental Representative.

.4 The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

1.3 SCOPE

.1 It is the responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

.2 Manufacturer's shop drawings to be submitted with seismic information on equipment structure, bracing and internal components and as required by Division 01.

.3 Provide restraint on all equipment and machinery, which is part of the building electrical services and systems, to prevent injury or hazard to persons and equipment in and around the structure. Restrain all such equipment in its normal position in the event of an earthquake.

.4 The total electrical seismic restraint design and field review and inspection will be by a B.C. registered professional structural engineer who specializes in the restraint of building elements. Contractor to allow for coordination, provision of seismic restraints, as well as all costs for the services of the Seismic Restraint Engineer. This engineer, herein referred to as the Seismic Consultant, will provide normal engineering functions as they pertain to seismic restraint of electrical installations.

.5 The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper allowance for such conditions in the tender.

.6 The Seismic Consultant shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.

.7 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.

.8 The Seismic Consultant shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.

.9 Include all costs associated with the Seismic installation and certification in the base tender.

1.4 SHOP DRAWINGS & SUBMITTALS

.1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the Seismic Consultant.

.2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Consultant.

2 Products

2.1 SLACK CABLE SYSTEMS

.1 Slack cable restraint systems shall be as designed and supplied by Vibra-Sonic Control or equal.

.2 Slack cable restraints shall be provided on suspended and shelf mounted transformers along with associated equipment and assemblies connected to them at the points of vertical support (4 points). The restraint wires shall be oriented at approximately 90° to each other (in plan), and tied back to the ceiling slab or its structure at approximately 45° to the slab or basic structure. The restraints shall be selected for a 1 g earthquake loading, i.e. each wire shall have a working load capacity equal to the weight of the transformer. The anchors in the structure shall be selected for a load equal to the weight of the transformers at a 45° pull.

.3 Slack cable systems to allow normal maintenance of equipment and shall not create additional hazard by their location or configurations. Contractor shall rectify any such installations at no additional cost, all to the satisfaction of the Departmental Representative and inspection authority having jurisdiction.

.4 Coordinate requirements of slack cables with suppliers prior to installation.

3 Execution

3.1 GENERAL

.1 All seismic restraints systems shall conform to local authority having jurisdiction and all applicable code requirements.

3.2 CONDUITS

.1 Provide restraint installation information and details on conduit and equipment as indicated below:

.2 Vertical Conduit:

.1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over 2 stories in height, at each floor by approved metal floor clamps.

.2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m [30 ft] o.c.

.3 Riser joints shall be braced or stabilized between floors.

.3 Horizontal Conduits:

.1 Supports - Horizontal conduit shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.

.2 EMT tubing - tubing shall be supported at approximately 1.2 m [4 ft] intervals for tubing.

.4 Provide transverse bracing at 12.2 m [40 ft] o.c. maximum unless otherwise noted. Provide bracing at all 90° bend assemblies, and pull box locations.

.5 Provide longitudinal bracing at 24.4 m [80 ft] o.c. maximum unless otherwise noted.

.6 Do not brace conduit runs against each other. Use separate support and restraint system.

.7 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.

.8 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.

.9 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

.10 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.

.11 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with Seismic Consultant and submit shop drawings to the Departmental Representative for his reference.

3.3 FLOOR MOUNTED EQUIPMENT

.1 Bolt all equipment, e.g. transformers, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the center of gravity to a seismic force of 0.5g. For equipment which may be subject to resonances, use a nominal 1.0 g seismic force.

.2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

3.4 LIGHT FIXTURES

.1 Fluorescent fixtures in suspended ceilings shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by at least two taught cables which are connected to the fixture at diagonal points.

.2 Surface and recessed style fixtures shall be hung independently of the ceiling system. Fixtures shall be secured to concrete or structural deck above by taught cables.

.3 Fixtures which are hung independently of ceiling systems shall have minimum of one seismic cable in addition to the chain or cable used to support the fixture. Seismic restraint cables shall be secured into the concrete or structural deck above.

.4 Cables shall be corrosion resistant and approved for the application.

.5 Fixtures which are rod hung shall have seismic ball alignment fittings at the ceiling and fixture.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

.2 Section 26 05 00 - Common Work Results - Electrical.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

.1 ANSI/IEEE 837-1989(R1996), Qualifying Permanent Connections Used in Substation Grounding.

.2 Canadian Standards Association, (CSA International)

.3 CAN/CSA Z32-1999, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

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

Part 2 Products

2.1 EQUIPMENT

.1 Clamps for grounding of conductor: size as indicated as required to electrically conductive underground water pipe.

.2 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.

.3 Rod electrodes: copper clad steel 19 mm dia by 3 m long.

.4 Plate electrodes: copper, surface area 0.2 m^2, 1.6 mm thick.

.5 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.

.6 Insulated grounding conductors: green.

.7 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

.8 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Bolted type conductor connectors.

.4 Thermit welded type conductor connectors.

.5 Bonding jumpers, straps.

.6 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.

.2 Install connectors in accordance with manufacturer's instructions.

.3 Protect exposed grounding conductors from mechanical injury.

.4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process, permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.

.5 Use mechanical connectors for grounding connections to equipment provided with lugs.

.6 Soldered joints not permitted.

.7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.9 Install separate ground conductor to outdoor lighting standards.

.10 Connect building structural steel and metal siding to ground by welding copper to steel.

.11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.12 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.13 Ground secondary service pedestals.

3.2 MANHOLES

.1 Install conveniently located grounding stud, electrode, size #6 stranded copper conductor in each manhole.

.2 Install ground rod in each manhole so that top projects through bottom of manhole. Provide with lug to which grounding connection can be made.

3.3 ELECTRODES

.1 Make ground connections to continuously conductive underground water pipe on street side of water meter.

.2 Install water meter shunt.

.3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.

.4 Install rod electrodes and make grounding connections.

.5 Bond separate, multiple electrodes together.

.6 Use size 4/0 AWG copper conductors for connections to electrodes.

.7 Make special provision for installing electrodes that will give [acceptable] resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.4 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting.

3.5 GROUNDING BUS

.1 Install copper grounding bus mounted on insulated supports on wall of electrical room.

.2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size #6 AWG.

3.6 COMMUNICATION SYSTEMS

.1 Install grounding connections for telephone, sound, fire alarm, intercommunication systems as follows:

.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

.2 Sound, fire alarm, intercommunication systems as indicated.

3.7 FIELD QUALITY CONTROL

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

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

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

Part 2 Products

2.1 SUPPORT CHANNELS

.1 U shape, size 41 x 41 mm, 2.5 mm thick, suspended set in poured concrete walls and ceilings].

Part 3 Execution

3.1 INSTALLATION

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 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 clips, 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 dia threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.10 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.

.12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

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

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.

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

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

Part 2 Products

2.1 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.2 CABINETS

.1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.

.2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm G1S plywood backboard for surface mounting.

Part 3 Execution

3.1 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.

.3 Install terminal block as indicated in Type T cabinets.

.4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.2 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.1-1998, Canadian Electrical Code, Part 1.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.

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

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347 V outlet boxes for 347 V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel 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.

.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

.3 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.4 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished 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-glavanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 CONDUIT BOXES

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

2.6 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.

Part 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. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.

.2 CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.

.3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.4 CSA C22.2 No. 83-M1985(R2003), Electrical Metallic Tubing.

.5 CSA C22.2 No. 211.2-M1984(R2003), Rigid PVC (Unplasticized) Conduit.

.6 CAN/CSA C22.2 No. 227.3-05, Non-metallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 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 21 - Construction/Demolition 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.

Part 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.

2.2 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel.

.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.

.4 Rigid pvc conduit: to CSA C22.2 No. 211.2.

.5 Flexible metal conduit: to CSA C22.2 No. 56 liquid-tight flexible metal conduit.

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.

.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 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.

Part 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 in unfinished areas.

.3 Use rigid galvanized steel threaded conduit except where specified otherwise.

.4 Use epoxy coated conduit underground in corrosive areas].

.5 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.

.6 Use rigid pvc conduit underground in corrosive areas.

.7 Use flexible metal conduit for connection to motors in dry areas, connection to 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 damp, wet or corrosive locations.

.9 Use explosion proof flexible connection for connection to explosion proof motors.

.10 Install conduit sealing fittings in hazardous areas. Fill with compound.

.11 Minimum conduit size for lighting and power circuits.

.12 Bend conduit cold:

.1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.13 Mechanically bend steel conduit over 19 mm diameter.

.14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.15 Install fish cord in empty conduits.

.16 Remove and replace blocked conduit sections.

.1 Do not use liquids to clean out conduits.

.17 Dry conduits out before installing wire.

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 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 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES:

.1 Cable trays and fittings

.2 Section 01 33 00 - Submittal Procedures.

.3 Section 01 74 19 - Construction Waste Management and Disposal.

.4 Section 26 05 00 - Common Work – Electrical.

.5 Section 26 05 25 - Seismic Restraints.

.6 Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.1 No. 126.1-02, Metal Cable Tray Systems.

1.3 SUBMITTALS

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

.2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.

.3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.

.4 Identify types of cable trays used.

.5 Show actual cable tray installation details and suspension system.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition 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.

Part 2 Products

2.1 GENERAL REQUIREMENTS

.1 Totally enclosed SOLID cable trays: CSA Class C, 150 mm deep, width as noted on the drawings, constructed of hot-dipped galvanized steel to form a cable supporting surface. Cable tray construction shall utilize turned down outer edges so as to form a smooth finish and provide additional lateral rigidity. The cable support surface shall be smooth and flat.

.2 Cable tray barrier strips: upper edge of barrier strip to be turned down so as to form a smooth finish and provide additional lateral rigidity. Barrier lower edge shall form an 'L' shape. Installed in the field using self-tapping screws. Barrier strips to be 100mm high in a 150mm deep cable tray with over to allow for cable cross-over. Provide minimum two (2) barrier strips in the cable tray.

.3 Complete with factory-produced straight lengths, fittings, connectors, elbows, tees, dead ends, crosses, reducers, supports, covers and drop-outs.

.4 Cable tray elbows, tees, and crosses shall have smooth and continuous curved edges. Reducers shall be "concentric" type. Elbows and tees to have maximum available radii where installation permits.

.5 Sections of cable tray and fittings shall be connected using factory-produced connection plates fitted on the outside faces of the tray in order to maintain a smooth interior joint.

.6 Conduit bushings for wiring to and from cable trays: T&B or equal insulated-throat bushings.

.7 Approved Manufacturers: Canstrut, Electrotray, Code Manufacturing Ltd., or approved equal.

Part 3 Execution

3.1 CABLE TRAYS

.1 Provide a complete continuous totally enclosed metal cable tray system for the support of communication system cables and install where shown on the drawings.

.2 Cable tray layouts and routing shown on the drawings are for general reference and estimating purposes only and do not show the exact final layout or all the required fittings, offsets, bends, and changes in elevations required to avoid obstacles such as ducts, beams, pipes, structural members, ceiling system supports, etc. Final layout of cable trays shall be coordinated with other trades on site and in consultation with the Departmental Representative.

.3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.4 Conduits extending services to or from cable tray shall have insulated throat grounding bushings on connectors and shall be properly supported and terminated on the side wall of the cable tray. Provide #6 AWG (or larger if required by Code) stranded bare copper bonding jumper from cable tray to each conduit grounding bushing serving the tray.

.5 Provide a continuous #2/0 AWG bare copper ground conductor along the entire length of the cable tray and provide additional grounding as required in accordance with the Canadian Electrical Code. Connect ground wire to each cable tray section using approved CSA mechanical lug/connector. Cable tray for telecommunications cabling shall be connected to ground bus in telecommunications rooms.

.6 Horizontal runs through walls which are fire, smoke, or sound barriers shall be sealed and be of a solid (no slots) type complete with solid top cover for 450 mm on both sides of the wall.

.7 Vertical runs shall be totally enclosed up to 2000 mm above floor level and shall be fire and smoke sealed.

.8 Cable trays shall be supported using the manufacturer's standard supports such that wherever possible one side of the tray is both accessible and unencumbered by support members so as to permit convenient laying in of cables. Otherwise utilize suspended trapeze racks, with cable trays securely bolted to the support assemblies. Provide additional supports under all fittings of 600 mm radius or larger. Brace all supports to

withstand the loads due to pulling in of cable. All supports shall permit a minimum of 150 mm vertical adjustment.

.9 Minimum access clearances between cable trays and adjacent conduits, pipes, ductwork, etc., shall be 305 mm vertically and 600 mm horizontally for cable trays. Coordinate closely with other trades to ensure a convenient space-conserving and accessible installation.

.10 Maintain minimum 450 mm separation between communication cable trays and any power feeders in conduits and cables to minimize electromagnetic interference. Do not attach conduits and cables containing power conductors to communication cable tray supports.

.11 Conduits containing communication cables only may be clamped to the communication cable tray support system. However, such conduits will not be permitted to be installed across the projected cross-section (i.e. width) of the cable tray in order not to impede access to the tray.

.12 Complete a typical portion of the cable tray installation and obtain the approval of the Departmental Representative prior to proceeding with the remainder of the tray installation.

3.2 CABLES IN CABLE TRAYS

.1 Use manufacturer-approved cable installation techniques in order to protect cables during installation. Do not install cables until the tray installation has been completed and the cables are safe from damage from construction operations. Damaged cables shall be replaced at no additional cost.

.2 Lay cables into cable tray. Use rollers when necessary to pull cables.

.3 Secure cables in cable tray at 6 m centres, with nylon ties.

.4 Identify cables every 30 m in accordance with Section 26 05 00 - Common Work Results - Electrical.

.5 Cables of different systems and of different voltage shall be separated from one another by specified manufacturer's barrier strips. The final position of barriers shall be as directed in the field. Barriers shall be continuous along the entire length of the cable tray.

.6 Communication cables shall be fastened together on a system-by-system basis by use of nylon cable ties on maximum 1200 mm centres.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.3 Section 06 10 00.01 - Rough Carpentry - Short Form: Plywood Backboard.

.4 Section 26 05 00 - Common Work Results - Electrical.

.5 Section 26 28 21 - Moulded Case Circuit Breakers.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2No.29-M1989 (R2000), Panelboards and Enclosed Panelboards.

1.4 SHOP DRAWINGS

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

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

Part 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 18kA (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 Two keys for each panelboard and key panelboards alike.

.6 Tin plated aluminum bus with full size neutral.

.7 Mains: suitable for bolt-on breakers.

.8 Trim with concealed front bolts and hinges.

.9 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank filler for all spaces.

2.2 BREAKERS

.1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.

Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.

.2 Common-trip breakers: with single handle for multi-pole applications.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.4 Circuit breakers with interchangeable trips as indicated.

.5 Circuit breaker ratings and interrupting capacity as shown and to match existing breaker kA rating. 347/600V circuit breakers to have minimum of 18,000 A IC symmetrical rms interrupting capacity rating. 120/208V circuit breakers to have minimum of 10,000 A IC symmetrical rms interrupting capacity rating

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Nameplate for each panelboard size 4 engraved .

.3 Nameplate for each circuit in distribution panelboards size 2 engraved .

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

Part 3 Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards in accordance with Section 06 10 00 - Rough Carpentry. Where practical, group panelboards on common backboard.

.3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results - Electrical or as indicated.

.4 Check for breaker installed correspond to short circuit ratings and trip setting in accordance with coordination study, provide coordination study for review prior to field installation.

.5 Provide *lamicoid* identification for all new breakers.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.3 Section 26 05 00 - Common Work Results - Electrical.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA-C22.2 No.42-99 (R2002), General Use Receptacles, Attachment Plugs and Similar Devices.

.2 CSA-C22.2 No.42.1-00, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

.3 CSA-C22.2 No.55-M1986(July 2001), Special Use Switches.

.4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.4 SHOP DRAWINGS AND PRODUCT DATA

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

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 SWITCHES

.1 20 A, 120 V, single pole, 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 Ivory toggle.

.3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.4 Switches of one manufacturer throughout project.

.5 Acceptable materials:

.1 Hubbell HBL.1221 20A series

.2 Leviton 1221-20A 120V series – 18221 347V

.3 Pass & Seymour PS20AC1 120V series – PS37201(3)0 347V

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 Ivory urea moulded housing.

.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 Ivory urea moulded housing.

.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.

.5 Acceptable materials:

.1 Hubbell 5252 heavy duty, construction series

.2 Leviton 5262 series

.3 Pass & Seymour 5262 series

2.3 COVER PLATES

.1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.

.2 Cover plates from one manufacturer throughout project.

.3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.4 Stainless steel, vertically brushed, 1 mm thick cover plates. Plastic ivory cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.

.5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

Part 3 Execution

3.1 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 - Electrical.

.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 - Electrical.

.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.3 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers, circuit breakers, ground-fault circuit-interrupters, fused circuit breakers, and accessory high-fault protectors.

1.2 RELATED SECTIONS

.1 Section [01 33 00 - Submittal Procedures].

.2 Section [01 74 21 - Construction/Demolition Waste Management and Disposal].

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA-C22.2 No. 5-[02], Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

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

.2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.5 Circuit breakers with interchangeable trips as indicated.

.6 Circuit breakers to have minimum 18 KA symmetrical rms interrupting capacity rating.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

.2 Supply and install matching circuit breaker to match the existing CDP and panelboards.

.3 Check circuit breaker operation in accordance with the manufacturer's requirements.

.4 Check for breaker installed correspond to short circuit ratings and trip setting in accordance with coordination study, provide coordination study for review prior to field installation.

.5 Provide *lamicoid* identification for all new breakers.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for fused and non-fused disconnect switches.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 35 29.06 - Health and Safety Requirements.

.3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.4 Section 26 05 00 - Common Work Results - Electrical.

.5 Section 26 28 13.01 - Fuses - Low Voltage.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.

.2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

1.4 SUBMITTALS

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

1.5 HEALTH AND SAFETY

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

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

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

.3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.

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

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Fusible, non-fusible, horsepower rated disconnect switch in CSA Enclosure, to CAN/CSA C22.2 No.4 size as indicated.

.2 Provision for padlocking in off switch position.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Quick-make, quick-break action.

.5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

CONSTRUCTION PHASE COMMISSIONING PLAN
Boiler Replacement

Huntingdon Port of Entry
Abbottsford, BC

April 2016

KANE CONSULTING

KANE CONSULTING

CONSTRUCTION PHASE COMMISSIONING PLAN

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INTRODUCTION – CONSTRUCTION PHASE COMMISSIONING

GOAL

To provide a quality-oriented process for achieving, verifying, and documenting that the performance of the project's replacement boiler plant and related systems meet the owner's requirements.

OBJECTIVES

1. Verify that the new equipment performs according to the Construction Documents by performing installation and start-up checks, as well as functional performance testing;
2. Verify that appropriate design and operational documentation is provided to the Owner; and
3. Verify that operation and maintenance personnel and occupants are properly trained.

SYSTEMS INCLUDED IN CONSTRUCTION PHASE COMMISSIONING

The Huntingdon Port of Entry, located in Abbottsford, BC, is undergoing a boiler plant retrofit for two of the buildings at the site, the CTF and the ITF facilities. 2 new boilers and associated pumps will be installed at each building, as well as 10 electric baseboard heaters.

COMMISSIONING ROLES AND RESPONSIBILITIES

It is important to clarify the roles and responsibilities of the Owner's Commissioning Authority (Kane Consulting) and Contractor's Commissioning Agent, and not confuse the two. The Commissioning Authority reports directly to the Owner. The Commissioning Authority reviews and spot-checks equipment installation and start-up checks, and develops, directs, and witnesses functional performance test procedures to be completed by the Contractor/Contractor's Commissioning Agent. The Commissioning Authority also verifies that training being provided is adequate. The Commissioning Authority will hold commissioning meetings, used to track the overall Commissioning process, but is not involved in day-to-day coordination of commissioning activities.

The Commissioning Agent is retained by and reports directly to the Contractor, and is responsible for completing, and documenting installation and start-up checks for all equipment included in the project scope. The Commissioning Agent also completes the functional performance tests as directed and witnessed by the Commissioning Authority. The Commissioning Agent also provides O&M training unless specified in the Contract Documents to be completed by other contractors or agencies. The Commissioning Agent may also be required to provide additional installation and start-up documentation and system demonstrations as required by the Contract Documents and regulatory authorities. The Commissioning Agent and/or Contractor are responsible for scheduling of day-to-day coordination of commissioning activities.

COMMISSIONING REPORT

Detailed descriptions of construction phase commissioning are noted below and form the Commissioning Plan for the project. The Commissioning report is a complementary document, using the same numbering, which provides the data and results specified in this document.

1 CONSTRUCTION PHASE COMMISSIONING PROCESS

The Construction Phase Commissioning Plan and the Commissioning Authority role in the project is to ensure that due diligence is being demonstrated by the contractors and design professionals.

NOTE: Commissioning through the use of a Commissioning Authority IS NOT intended to change any of the traditional design professionals' and construction management's roles or responsibilities including the requirement for traditional commissioning/balancing agents to undertake the field measurements and adjustments.

1.1 Installation and Start Up Checks

Installation & start-up check sheets provide a written record that the contractor verified their own installation works. Typically the Contractor or Contractor's Commissioning Agent have their own format for installation check sheets, and they shall submit them to the Commissioning Authority for review and approval. The contractor can use sample installation & start-up check sheets provided in Appendix A. As construction progresses, the Contractor or Contractor's Commissioning Agent shall complete the installation & start-up check sheets and provide them to the Commissioning Authority.

Installation & start-up checks for mechanical equipment should contain at a minimum:

- Installation verification (all components installed as per drawings/spec, mfg. instructions)
- All necessary wiring, ducting, piping, controls are completed
- Motor direction rotation checked
- Overload protection adjusted and checked
- Disconnects and starters installed and tested
- Point to point verification of control points

The Commissioning Authority will review the installation and start-up check sheets for completeness, verify a sample for accuracy, and provide any necessary feedback to the design professionals and contractors. The Commissioning Authority will also witness the start-up of key equipment. Note that this does not replace any of the requirements of the design professionals with regards to documentation and approval.

1.2 Functional Performance Testing

Functional Performance Test (FPT) procedures will be developed by the Commissioning Authority and submitted to the design professionals and contractors for review and approval. Once the equipment has been be started up and inspected by the design professionals, the functional performance of the equipment and their related systems will be demonstrated by the contractor. The results of this will be witnessed and documented by the Commissioning Authority as follows:

- Contractor completes and submits installation & start-up check sheets and confirms systems are up and running and ready for functional performance testing.
- The Commissioning Authority will direct and witness the FPT of the equipment at a variety of loads and conditions, and sign-off on the FPT results sheets that the equipment meets the Owner's requirements and the Contract documents. FPT are to be performed by the Contractor/Contractor's Commissioning Agent, as they are the ones operating and manipulating equipment and controls.
- Any deficiencies or tests that fail to meet the above requirements will be reported back to the design professionals and the Owner. The design professionals should work to resolve any issues with the contractor providing resolution to Owner and Commissioning Authority.

We plan to direct and witness the FPT, which are to be conducted by the contractor for the following systems:

- Boiler plants in the ITF and CTF facilities, and heating at end devices (air handling unit heating coils)
- Electric baseboard heaters

The contractor will assist in this process by having personnel from the mechanical, electrical, and controls contractor available for the duration of FPT for the LEED Commissioning process. The total duration of functional performance testing for this project is anticipated to be 1 day. We have included in Appendix B a sample set of FPT procedures to show the anticipated level of detail that will be covered. The Commissioning Documentation Tracking sheet in Appendix C will be used to track the progress of installation, start-up, and FPT completion.

1.3 Operation & Maintenance Manuals and Training

We ask that draft O&M manuals and balancing reports be made available, and as Commissioning Authority we will review and provide comment in case key elements are missing.

Similarly, we ask to review operator training and demonstration information on equipment start-up, shut-down, troubleshooting, and O&M be made available prior to the provision of training. Kane will witness training and demonstrations.

2 APPENDICES

Appendix A – Sample Installation and Start Up Check Sheets

COMMISSIONING INSTALLATION / START-UP CHECKS

Project: Huntingdon Border Crossing
System/Area Served:_____

Equipment: **Boiler**
Location: ITF Mechanical Room

ITEM	B	B	COMMENTS
INSTALLATION CHECKS	B-I1	B-I2	
Mounting/support system			
Seismic restraints			
Maintenance clearance			
Local valving/piping correct (including expansion tanks and make-up water).			
Condensate piping, neutralizer			
Chemical cleaning and treatment completed			
Temperature and pressure gauges			
Pressure relief valve			
Safety interlocks- low water and high temperature			
Combustion air supply and ventilation			
Insulation			
Venting			
Fuel system (including emergency shutdown)			
Electrical wiring complete			
Overload protection (sized correctly)			
Disconnect switch (tested)			
Control system - point to point checks complete			
START-UP CHECKS			
Start HWS pumps to create load.			
Start boiler circulation pumps.			
Boiler startup by supplier			
Supplier certificate or log provided for start-up and all specified and regulatory tests.			
Installation Checks by:		Date:	
Start-up Checks by:		Date:	

COMMISSIONING INSTALLATION / START-UP CHECKS

Project: Huntingdon Border Crossing
System/Area Served:_____

Equipment: **Boiler**
Location: CTF Mechanical Room

ITEM	B	B	COMMENTS
INSTALLATION CHECKS	B-C1	B-C2	
Mounting/support system			
Seismic restraints			
Maintenance clearance			
Local valving/piping correct (including expansion tanks and make-up water).			
Condensate piping, neutralizer			
Chemical cleaning and treatment completed			
Temperature and pressure gauges			
Pressure relief valve			
Safety interlocks- low water and high temperature			
Combustion air supply and ventilation			
Insulation			
Venting			
Fuel system (including emergency shutdown)			
Electrical wiring complete			
Overload protection (sized correctly)			
Disconnect switch (tested)			
Control system - point to point checks complete			
START-UP CHECKS			
Start HWS pumps to create load.			
Start boiler circulation pumps.			
Boiler startup by supplier			
Supplier certificate or log provided for start-up and all specified and regulatory tests.			
Installation Checks by:		Date:	
Start-up Checks by:		Date:	

HVAC COMMISSIONING INSTALLATION / START-UP CHECKS

Project: Huntingdon Border Crossing
System/Area Served:_____

Equipment: **Pumps**
Location: ITF Mechanical Room

ITEM	P	P	P	P	P	P	COMMENTS
INSTALLATION CHECKS	P-I1	P-I2	P-I3	P-I4	P-I5	P-I6	
Motor size (hp)							
Motor voltage / phase							
Piping and valving							
Mounting/support system and vibration isolation							
Seismic restraints							
Freedom of rotation							
Lubrication							
Electrical wiring complete							
Overload protection (sized correctly)							
Disconnect switch							
Maintenance Access							
Pressure /Temperature Gauges							
ECM motor controller							
Motor rated for VFD service			n/a	n/a			
Control system - point to point checks complete							
START-UP CHECKS							
VFD Start-up by manufacturer's rep. (report attached)			n/a	n/a			
Loop filled, system balanced							
Direction of rotation							
Electrical interlocks - stop/start							
Vibration & noise level acceptable							
Motor Amps - Rated:_____Actual :_____							
Motor Volts - Rated:_____Actual:_____							

Installation Checks by:		Date:
Start-up Checks by:		Date:

HVAC COMMISSIONING INSTALLATION / START-UP CHECKS

Project: Huntingdon Border Crossing Equipment: **Pumps**

System/Area Served:_____ Location: CTF Mechanical Room

ITEM	P	P	P	P	P	COMMENTS
INSTALLATION CHECKS	P-C1	P-C2	P-C3	P-C4	P-C5	
Motor size (hp)						
Motor voltage / phase						
Piping and valving						
Mounting/support system and vibration isolation						
Seismic restraints						
Freedom of rotation						
Lubrication						
Electrical wiring complete						
Overload protection (sized correctly)						
Disconnect switch						
Maintenance Access						
Pressure /Temperature Gauges						
ECM motor controller						
Motor rated for VFD service			n/a			
Control system - point to point checks complete						
START-UP CHECKS						
VFD Start-up by manufacturer's rep. (report attached)			n/a			
Loop filled, system balanced						
Direction of rotation						
Electrical interlocks - stop/start						
Vibration & noise level acceptable						
Motor Amps - Rated:_____Actual :_____						
Motor Volts - Rated:_____Actual:_____						

Installation Checks by:		Date:
Start-up Checks by:		Date:

COMMISSIONING INSTALLATION / START-UP CHECKS

Project: Huntingdon Border Crossing
Equipment: **Baseboard Heater**
System/Area Served:_____ Location:_____

ITEM	1	2	3	4	5	6	7	8	9	10	COMMENTS
INSTALLATION CHECKS											
Mounting/support system											
Electrical wiring complete											
Thermostat installed											
START-UP CHECKS											
Heating mode functional											
Installation Checks by:										Date:	
Start-up Checks by:										Date:	

Appendix B– Sample Functional Performance Test Procedures

BOILER PLANT FUNCTIONAL PERFORMANCE TEST

System:	2 boilers, 2 boiler pumps, 2 heating water distribution pumps
Mode:	Start-up and normal operation
Action to be verified:	-Boiler plant is enabled by the DDC system -Boilers are staged to maintain heating water return setpoint of 49C, supply water setpoint to vary based on room temp/ demand (Hot water reset) -Heating water pumps VFD speeds modulate to maintain differential pressure setpoint of __ psi -Heating water pumps operate as duty/standby; standby pump runs upon lduty pump failure
Method	<u>Boiler Staging and Temperature Control</u> -Override heating water return setpoint upwards, observe -Boiler pump starts, boiler starts firing once flow is proven -Boiler capacity ramps up to achieve setpoint -Observe that heating water setpoint is met (observe control loop stability) -Observe that lag boiler starts as required Override heating water return setpoint downwards, observe -Boiler capacity ramps down to achieve setpoint (observe control loop stability) -Lag boiler and associated pump remain off Override heating water return setpoint further downwards -Boilers and associated pumps stop <u>Hot Water Reset</u> -Override space temperature setpoints upward/downward to increase/decrease building load, observe: -DDC controls increase/decrease supply water temperature setpoint as necessary to meet demand -Manually turn off one boiler pump, observe lag boiler and pump start and alarm be sent to BMS -Observe lead pump rotation on every start <u>Heating Water Pumps (P-I5, P-I6; P-C4, P-C5)</u> With heating water distribution pump running, increase/decrease dP setpoint -Observe VFD modulates to meet setpoint -Check control loop response & stability Turn duty pump off at the VFD/disconnect, observe: -Standby pump starts, alarm is generated Observe weekly rotation schedule for duty pump
Result Narrative:	B-I1, B-I2, P-I1, P-I2
Result Narrative:	B-C1, B-C2, P-C1, P-C2

AIR HANDLING UNIT SAMPLE FUNCTIONAL PERFORMANCE TEST

System:	Air handling unit heating coil pump, control valve
Mode:	Occupied & Unoccupied Mode
Action to be verified:	-Heating coil pump is enabled when there is a call for heating or based on outdoor air temperature (runs continuously when OAT <2C) -Heating coil control valve modulates to maintain supply air temperature setpoint -Low temperature shutdown (if applicable)
Method	<u>Normal Operation</u> -Override supply air temperature setpoint downward, override outdoor air temperature setpoint above outside air temperature, observe heating coil pump continue to run -Override outdoor air temperature setpoint above outside air temperature, increase supply air temperature setpoint, observe heating coil pump turn on and control valve modulate to meet setpoint -Measure supply air temperature at nearest diffuser <u>Freeze Protection (if applicable)</u> -Override freeze stat temperature setpoint downward, observe heating coil pump stay on and heating coil control valve modulate open and outdoor air damper close / supply fan shut down
Result Narrative:	AHU-1, P-I3
Result Narrative:	AHU-2, P-I4
Result Narrative:	AHU-3, P-C3

ELECTRIC BASEBOARD HEATER SAMPLE FUNCTIONAL PERFORMANCE TEST

System:	Electric Baseboard Heaters
Mode:	Normal Operation
Action to be verified:	Temperature Control -Heating is activated to maintain space temperature setpoint
Method	Increase space temperature setpoint, observe: -Electric heating cycles on until setpoint is reached
Result Narrative:	EBB-1
	EBB-2
	EBB-3
	EBB-4
	EBB-5
	EBB-6
	EBB-7
	EBB-8
	EBB-9
	EBB-10

Appendix C – Commissioning Documentation Tracking

CxA = Commissioning Authority, appointed by and reporting to the Owner, reviews and spot-checks contractor-completed installation & start-up checks, and directs and witnesses all functional performance tests.

Cx Agent = Commissioning Agent, a member of the Contractor's team in charge of co-ordinating and carrying out installation & start-up checks, as well as functional performance testing.

System	Equipment	Installation & Start-up Checks			Functional Performance Testing (FPT)	
		Installation & Start-up Checks by:	Installation Checks Completed ✓	Start-up Checks Completed ✓	FPT by:	FPT Completed ✓
Heating Plant	Boilers (B-I1, BI2; B-C1, B-C2)	Boiler rep / Cx Agent			Controls Contractor/ Cx Agent, CxA	
	Boiler & HW distribution pumps	Mechanical contractor/ Cx Agent			Controls Contractor/ Cx Agent, CxA	
	Pump VFD's	VFD rep			n/a – incl. above	n/a – incl. above
Zone-level HVAC	Air handling unit heating coil pumps (P-I3, P-I4; P-C3)	Mech. Contractor/ Cx Agent			Controls Contractor/ Cx Agent, CxA	
	Electric baseboard heaters (EBB-1 to EBB-10)	Mech. Contractor/ Cx Agent			Controls Contractor/ Cx Agent, CxA	
Building Automation System	Point to Point Checks	Controls Contractor			n/a – incl. above	n/a – incl. above