

Part 1 General

1.1 MINIMUM STANDARDS

- .1 Execute Work to meet or exceed the latest edition of:
 - .1 Manitoba Building Code, including all amendments up to project date.
 - .2 Rules and regulations of authorities having jurisdiction.
 - .3 Occupational Health and Safety Act,
 - .4 Canadian Construction Safety Code,
 - .5 Contract documents.
 - .6 Workplace Safety and Health;
 - .7 Canadian Electrical Code;

1.2 STORAGE OF EQUIPMENT AND MATERIALS

- .1 Contractor to co-ordinate with the Contract Administrator.

1.3 FEES, PERMITS AND CERTIFICATES

- .1 Provide authorities having jurisdiction with information requested.
- .2 Pay fees and obtain certificates and permits required.
- .3 Furnish certificates and permits when requested.

1.4 DOCUMENTS

- .1 Keep on copy of contract documents and shop drawings on the site.

1.5 AS-BUILT RECORD DRAWINGS

- .1 As Work progresses and as required, record significant deviations from the Contract drawings. Prior to Preliminary Acceptance, submit one copy of As-Constructed drawings to Contract Administrator. Refer to sections 013300 and 017800.

1.6 MATERIAL AND EQUIPMENT

- .1 Use new products unless otherwise specified.
- .2 Deliver and store material and equipment to manufacturer's instructions with manufacturer's labels and seals intact.

1.7 CUTTING AND REMEDIAL WORK

- .1 Coordinate Work to keep cutting and remedial Work to a minimum.

1.8 FASTENINGS

- .1 Provide fastenings of type, size and spacing required to assure secure anchorage.
 - .2 Obtain Contract Administrator's approval before using explosive actuated fasteners.
-

1.9 CONSTRUCTION TIME AND SCHEDULING

- .1 In conjunction with and in form acceptable to Contract Administrator provide within 10 working days after contract award, schedule showing dates for:
- Submission of shop drawings, material tests and samples.
 - Delivery of equipment and materials.
 - Commencement and completion of Work of each major component of the Work.
 - Final completion date within time period required by contract documents.

1.10 SUPERVISION

- .1 Provide the necessary supervision and qualified tradesmen to ensure that flow of materials and on-site installation compatible with the overall project schedule and progress.

1.11 CONTRACTOR'S USE OF PREMISES

- .1 The Contract Administrator will define the Contractor's use of the premises.
.2 Make arrangements with the Contract Administrator if additional areas are required. Obtain written agreements and submit copies to Contract Administrator.
.3 Confine operations within easements for construction, storage and access as shown on Contract Drawings.
.4 Service shutdowns that impact the normal operation of the facility shall be limited to after hour shifts not exceeding 8 hours. All services shall be restored prior to opening of the facility next day. The dates of shutdowns shall be co-ordinated with the Contract Administrator.
.5 Work shall be restricted to after normal operating hours of the pool after December 14th, 2018.

1.12 QUALITY CONTROL

- .1 Adhere to manufacturer's recommendations with respect to handling, preparation, installation, testing, operation or protection of any product or material to be incorporated in Work.
.2 Ensure that all materials supplied are compatible with each other unless specific adjacent materials have been specified. Correct any defective Work caused by non-compatibility of materials.
.3 Where practical or desirable, tests will be conducted by Contract Administrator on materials and equipment to be incorporated into permanent Works before delivery to site.
.4 Submit to Contract Administrator full information on materials, equipment and related arrangements to be furnished.
.5 Submit information in a form approved by Contract Administrator
.6 Submit sufficient information to enable Contract Administrator to determine whether proposed materials, equipment, and arrangements meet contract requirements.

1.13 PROJECT MEETINGS

- .1 Project meeting will be held at times and locations approved by the Contract Administrator.

1.14 DEMONSTRATION AND TRAINING

- .1 Provide training as per Section 01 79 00
-

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Submit to Contract Administrator submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable. Review submittals prior to submission to Contract Administrator. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .5 Notify Contract Administrator, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .6 Verify field measurements and affected adjacent Work are co-ordinated.
- .7 Contractor's responsibility for errors and omissions in submission is not relieved by Contract Administrator's review of submittals.
- .8 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Contract Administrator review.
- .9 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .3 Allow 14 days for Contract Administrator's review of each submission.
- .4 Adjustments made on shop drawings by Contract Administrator are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Contract Administrator prior to proceeding with Work.
- .5 Make changes in shop drawings as Contract Administrator may require, consistent with Contract Documents. When resubmitting, notify Contract Administrator in writing of revisions other than those requested.
- .6 Accompany submissions with transmittal letter, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.

- .7 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - Subcontractor.
 - Supplier.
 - 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:
 - Fabrication.
 - Layout, showing dimensions, including identified field dimensions, and clearances.
 - Setting or erection details.
 - Capacities.
 - Performance characteristics.
 - Standards.
 - Operating weight.
 - Wiring diagrams.
 - Single line and schematic diagrams.
 - Relationship to adjacent Work.
 - .8 After Contract Administrator's review, distribute copies.
 - .9 Submit electronic (PDF format) copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Contract Administrator where shop drawings will not be prepared due to standardized manufacture of product.
 - .10 Submit electronic (PDF format) copies of test reports for requirements requested in specification Sections and as requested by Contract Administrator.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .11 Submit electronic (PDF format) copies of certificates for requirements requested in specification Sections and as requested by Contract Administrator.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
 - .12 Submit one electronic PDF copy and 3 hard copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Contract Administrator.
 - .13 Delete information not applicable to project.
 - .14 Supplement standard information to provide details applicable to project.
-

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

1.3 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic copy of colour digital photography in jpg format, standard resolution monthly with progress statement and as directed by Contract Administrator.
- .2 Project identification: name and number of project and date of exposure indicated.
- .3 Frequency of photographic documentation: weekly.
- .1 Upon completion of: excavation, foundation, framing and services before concealment, and as directed by Contract Administrator.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Province of Manitoba
 - .1 The Workers Compensation Act RSM 1987 - Updated 2006.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in Work plan.
- .3 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .4 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.3 SAFETY ASSESSMENT

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

1.4 GENERAL REQUIREMENTS

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

1.5 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.

1.6 COMPLIANCE REQUIREMENTS

- .1 Comply with The Workers Compensation Act, Workplace Safety Regulation.
- .2 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

1.7 UNFORSEEN HAZARDS

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

1.8 HEALTH AND SAFETY CO-ORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:
 - .1 Have working knowledge of occupational safety and health regulations.
 - .2 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
 - .3 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

1.9 POSTING OF DOCUMENTS

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

1.10 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction.

1.11 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 INSPECTION

- .1 Allow Contract Administrator access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Contract Administrator instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Contract Administrator will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such Work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Contract Administrator shall pay cost of examination and replacement.

1.2 INDEPENDENT INSPECTION AGENCIES

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

1.3 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

1.4 PROCEDURES

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

1.5 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by
-

Contract Administrator as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.

- .2 Make good other Contractor's Work damaged by such removals or replacements promptly.
- .3 If in opinion of Contract Administrator it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Contract Administrator will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents.

1.6 REPORTS

- .1 Submit electronic copy of inspection and test reports to Contract Administrator.
- .2 Provide copies to Subcontractor of Work being inspected or tested, manufacturer or fabricator of material being inspected or tested.

1.7 TESTS AND MIX DESIGNS

- .1 Furnish test results and mix designs as requested.
- .2 Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Contract Administrator and may be authorized as recoverable.

1.8 MOCK-UPS

- .1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of Sections required to provide mock-ups.
- .2 Construct in locations acceptable to Contract Administrator.
- .3 Prepare mock-ups for Contract Administrator review with reasonable promptness and in orderly sequence, to not cause delays in Work.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 If requested, Contract Administrator will assist in preparing schedule fixing dates for preparation.
- .6 Remove mock-up when acceptable to Contract Administrator.
- .7 Mock-ups may remain as part of Work when acceptable to Contract Administrator.
- .8 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when.

1.9 MILL TESTS

- .1 Submit mill test certificates as required of specification Sections or requested by Contract Administrator.

1.10 EQUIPMENT AND SYSTEMS

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.
-

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 INSTALLATION AND REMOVAL

- .1 Provide temporary utilities controls in order to execute Work expeditiously.
- .2 Remove from site all such Work after use.

1.3 TEMPORARY HEATING AND VENTILATION

- .1 Provide temporary heating and ventilation as required during construction period, including attendance, maintenance and fuel.

1.4 TEMPORARY POWER AND LIGHT

- .1 Contractor is responsible for all power and lighting required during construction.
- .2 Provide and maintain temporary lighting throughout project.

1.5 TEMPORARY COMMUNICATION FACILITIES

- .1 Provide and pay for temporary telephone, fax, data hook up, necessary for own use.

1.6 FIRE PROTECTION

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by governing codes and regulations.
- .2 Burning rubbish and construction waste materials is not permitted on site.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-0121-M1978(R2003), Douglas Fir Plywood.
 - .3 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.
 - .4 CAN/CSA-Z321-96(R2001), Signs and Symbols for the Occupational Environment.
- .2 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 INSTALLATION AND REMOVAL

- .1 Indicate use of supplemental or other staging area.
- .2 Provide construction facilities in order to execute Work expeditiously.
- .3 Remove from site all such Work after use.

1.3 SCAFFOLDING

- .1 Scaffolding in accordance with CAN/CSA-S269.2.

1.4 HOISTING

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

1.5 SITE STORAGE/LOADING

- .1 Confine Work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.
- .2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

1.6 CONSTRUCTION PARKING

1.7 SECURITY

- .1 Provide and pay for responsible security personnel to guard site and contents of site after working hours and during holidays.

1.8 EQUIPMENT, TOOL AND MATERIALS STORAGE

- .1 Provide and maintain, in clean and orderly condition, lockable containers for storage of tools, equipment and materials, in an area designated by Contract Administrator.

1.9 SANITARY FACILITIES

- .1 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

- .2 The Contractor shall provide sanitary facilities for workers. (The Contractor may use existing sanitary facilities designated by Contract Administrator during the shutdown period identified in D13.5 provided the facilities are kept clean.)

1.10 PROTECTION AND MAINTENANCE OF TRAFFIC

- .1 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and Work, and erection and maintenance of adequate warning, danger, and direction signs
- .2 Protect travelling public from damage to person and property.
- .3 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.
- .4 Dust control: adequate to ensure safe operation at all times.
- .5 Remove, upon completion of Work, all temporary roads.

1.11 CLEAN-UP

- .1 Remove construction debris, waste materials, packaging material from Work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

Part 1 General

1.1 PROJECT CLEANLINESS

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

1.2 FINAL CLEANING

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

- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .16 Sweep and wash clean paved areas.
- .17 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .18 Clean roofs, downspouts, and drainage systems.
- .19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .20 Remove snow and ice from access to building.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .3 Provide one copy in electronic (PDF) format to Contract Administrator for review and comment. The copy will be returned with Contract Administrator's comments.
- .4 Revise content of documents as required prior to final submittal.
- .5 Two weeks prior to Substantial Performance of the Work, submit to the Contract Administrator, three final copies of operating and maintenance manuals in English.
- .6 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
- .7 Furnish evidence, if requested, for type, source and quality of products provided.
- .8 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .9 Pay costs of transportation.

1.2 FORMAT

- .1 Organize data as instructional manual (Hardcopy and Electronic(PDF) format).
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.3 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project; Date of submission; names.
 - .1 Addresses, and telephone numbers of Contract Administrator and Contractor with name of responsible parties.
 - .2 Schedule of products and systems, indexed to content of volume.
 - .2 For each product or system:
 - .1 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 identify specific 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.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure.
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

1.4 AS-BUILTS AND SAMPLES

- .1 Maintain, in addition to requirements in General Conditions, at site for Contract Administrator one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples. Field test records.
 - .6 Inspection certificates.
 - .7 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Contract Administrator.

1.5 RECORDING ACTUAL SITE CONDITIONS

- .1 Record information on set of black line opaque drawings provided by Contract Administrator.
 - .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
 - .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
 - .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
-

- .5 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.6 EQUIPMENT AND SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Additional requirements: as specified in individual specification sections.

1.7 MATERIALS AND FINISHES

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
 - .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
 - .3 Moisture-Protection and Weather-Exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
 - .4 Additional Requirements: as specified in individual specifications sections.
-

1.8 SPARE PARTS

- .1 Provide spare parts, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site; place and store.
- .4 Receive and catalogue items. Submit inventory listing to Contract Administrator. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.9 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 site; place and store.
- .4 Receive and catalogue items. Submit inventory listing to Contract Administrator. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.10 SPECIAL TOOLS

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to site; place and store. Receive and catalogue items. Submit inventory listing to Contract Administrator. Include approved listings in Maintenance Manual.

1.11 STORAGE, HANDLING AND PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Contract Administrator.

1.12 WARRANTIES AND BONDS

- .1 Develop warranty management plan to contain information relevant to Warranties.
 - .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Contract Administrator approval.
 - .3 Warranty management plan to include required actions and documents to assure that Contract Administrator receives warranties to which it is entitled.
 - .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
 - .5 Submit, warranty information made available during construction phase, to Contract Administrator for approval prior to each monthly pay estimate.
-

- .6 Assemble approved information in binder and submit upon acceptance of Work. Organize binder as follows:
 - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
 - .2 List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
 - .3 Obtain warranties and bonds, executed in duplicate by Subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of Work.
 - .4 Verify that documents are in proper form, contain full information, and are notarized.
 - .5 Co-execute submittals when required.
 - .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Contract Administrator's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, Subcontractors, manufacturers or suppliers involved.
 - .2 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
 - .3 Procedure and status of tagging of equipment covered by extended warranties.
 - .4 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .9 Respond in a timely manner to oral or written notification of required construction warranty repair Work.
- .10 Written verification will follow oral instructions. Failure to respond will be cause for the Contract Administrator to proceed with action against Contractor.

1.13 WARRANTY TAGS

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Contract Administrator.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.

- .4 Indicate following information on tag:
- .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.
 - .8 Installation Date:

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to Contract Administrator's personnel two weeks prior to date of final inspection.
- .2 Contractor shall submit the course contents to Contract Administrator's review minimum of 2 weeks prior to the training session. The Contractor shall incorporate all comments from the Contract Administrator and submit the finalized course content at least two weeks prior to first training session.
- .3 Contract Administrator will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

1.2 QUALITY CONTROL

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

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Contract Administrator's approval. Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .3 Give time and date of each demonstration, with list of persons present.

1.4 CONDITIONS FOR DEMONSTRATIONS

- .1 Equipment has been inspected and put into operation.
- .2 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.5 PREPARATION

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

1.6 DEMONSTRATION AND INSTRUCTIONS

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

1.7 TIME ALLOCATED FOR INSTRUCTIONS

- .1 For each training session, allow full 8 hour day for instruction and training.
-

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Acronyms:
 - .1 Cx - Commissioning.
 - .2 O&M - Operation and Maintenance.
 - .3 PI - Product Information.
 - .4 PV - Performance Verification.
 - .5 TAB - Testing, Adjusting and Balancing.

1.2 COMMISSIONING PLAN

- .1 Comprehensive commissioning plan shall be provided by Contractor for the review of Contract Administrator minimum of two weeks prior to commissioning. The commissioning plan shall detail list of actions to be carried out on each day of commissioning period. The commissioning plan shall include a schedule that would indicate the dates of commissioning. It shall also include commissioning forms to be filled out by the Contractor to record and document the results of commissioning procedures. (Commissioning forms are to be developed by Contractor with input from Contract Administrator.)
- .2 Pre-commissioning of the Air Handling Unit F-6 is required before connecting the supply duct to the existing combustion air riser. All control systems must be fully tested.
- .3 Provide final commissioning after connection of the supply air duct to the existing riser.

1.3 GENERAL

- .1 CX is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
 - .2 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

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

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review contract documents, confirm by writing to Contract Administrator.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Contract Administrator.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.
 - .9 Complete TAB procedures on systems, submit TAB reports to Contract Administrator for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Contract Administrator in writing of discrepancies and deficiencies on finished Works.

1.6 SUBMITTALS

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

1.7 COMMISSIONING DOCUMENTATION

- .1 Contract Administrator to review and approve Cx documentation.
- .2 Provide completed and approved Cx documentation to Contract Administrator.

1.8 STARTING AND TESTING

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

1.9 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days' notice prior to commencement.
- .2 Contract Administrator representative to witness of start-up and testing.

1.10 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by Contract Administrator.
 - .3 Obtain written approval of test results and documentation from Contract Administrator before delivery to site.
-

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

1.11 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Contract Administrator after distinct phases have been completed and before commencing next phase.
- .4 Document required tests on approved PV forms.

1.12 START-UP DOCUMENTATION

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

1.13 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

- .2 With assistance of manufacturer develop written maintenance program and submit Contract Administrator for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.14 TEST RESULTS

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

1.15 START OF COMMISSIONING

- .1 Start Cx after elements of the facility affecting start-up and performance verification of systems have been completed.

1.16 INSTRUMENTS / EQUIPMENT

- .1 Provide the following equipment as required:
 - .1 2-way radios.
 - .2 Ladders.
 - .3 Equipment as required to complete Work.

1.17 COMMISSIONING PERFORMANCE VERIFICATION

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

1.18 WITNESSING COMMISSIONING

- .1 Contract Administrator representative to witness activities and verify results.

1.19 AUTHORITIES HAVING JURISDICTION

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

1.20 REPEAT VERIFICATIONS

- .1 Assume costs incurred by Contract Administrator for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Contract Administrator's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Contract Administrator deems Contractor's request for second verification was premature.

1.21 DEFICIENCIES, FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Contract Administrator.
- .2 Report problems, faults or defects affecting Cx to Contract Administrator in writing. Stop Cx until problems are rectified. Proceed with written approval from Contract Administrator.

1.22 COMPLETION OF COMMISSIONING

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

1.23 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.24 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.25 OCCUPANCY

- .1 Cooperate fully with Contract Administrator during stages of acceptance and occupancy of facility.

1.26 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited with Contract Administrator.

1.27 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10 of specified values.

- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .1 Unless otherwise specified actual values to be within +/- 2% of recorded values.

1.28 PERFORMANCE TESTING

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.
 - .2 Commissioning forms provided herein will be updated as required by Contract Administrator during construction.

1.2 INSTALLATION/START-UP CHECK LISTS

- .1 Include the following data:
 - .1 Product manufacturer's installation instructions and recommended checks.
 - .2 Special procedures as specified in relevant technical sections.
 - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Contract Administrator supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Contract Administrator.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 SAMPLES OF COMMISSIONING FORMS

- .1 Contract Administrator will develop and provide to Contractor required project-specific Commissioning forms.
- .2 Revise items on Commissioning forms to suit project requirements.

1.4 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from Contract Administrator develop appropriate verification forms and submit to Contract Administrator for approval prior to use.

1.5 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
 - .2 Strategy for Use:
 - .1 Contract Administrator provides Contractor project-specific Commissioning forms with Specification data included. Contract Administrator shall update the commissioning forms as required prior to commissioning.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
-

- .5 Verify operation in specified normal and emergency modes and under specified load conditions.
- .6 Record analytical and substantiating data.
- .7 Verify reported results.
- .8 Form to bear signatures of recording technician and reviewed and signed off by Contract Administrator.
- .9 Submit immediately after tests are performed.
- .10 Reported results in true measured SI unit values.
- .11 Provide Contract Administrator with originals of completed forms.
- .12 Maintain copy on site during start-up, testing and commissioning period.

1.6 LANGUAGE

- .1 To suit the language profile of the awarded contract.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Integrated Systems Review

Date:

System to be Reviewed: Air Handling Units (F-6)

Components of Systems:

Visual Review

Item	Pass/Fail	Comments
Equipment installed, operational, accessible for maintenance, free of defect.		
All shipped loose parts installed.		
All control system functions and interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed.		
Terminal screws and wiring connections secure in control and electrical panels.		
Test and balance (TAB) complete and approved for the air and hydronic systems.		
All start-up deficiency items for this equipment corrected.		
Safeties and operating ranges reviewed.		
Equipment clean inside and out.		
Equipment and duct identification complete.		
No damage to coil fins, bent fins combed straight.		
Access doors in place and large enough to maintain service points.		
Damper linkages are tight and dampers are in correct positions when power is off.		
No unusual noise or vibrations.		

Systems Verification

Test to be Performed	Heating temperature control. Increase supply air temperature set point by 5 deg. C.
Desired Result	During heating mode, air handling units modulate associated 3-way control valves open to maintain supply air temperature at set point. Control valves modulate close once the set point is satisfied.
Pass Fail	
Comments	

Test to be Performed	Boiler System Interlock. With the fan ON, disconnect power to it.
Desired Result	Supply air flow switch detects loss of air flow and shut down the boilers.
Pass Fail	
Comments	

Test to be Performed	Boiler System Interlock. Start each unit and disconnect power to the damper actuator when it is 50% open.
Desired Result	Damper open limit switch detects damper failure and shut down boilers.
Pass Fail	
Comments	

Test to be Performed	Supply Fan Failure. With fan ON, disconnect power to them.
Desired Result	Fans turn off and an alarm is generated in DDC system.
Pass Fail	
Comments	

Test to be Performed	Freeze stat. Disconnect the freeze stat sensor and replicate a low temperature signal to the DDC.
Desired Result	Air Handling Unit shuts down and an alarm is generated in the DDC system.
Pass Fail	
Comments	

CIRCULATING PUMP			
Pump Number		Spec Reference	
System Served			
Location			
Pump Data	Specified	Shop Drawings	Installed
Manufacturer			
Liquid			
Model Number			
Size (suction x discharge)			
Capacity L/s (GPM)			
Head Pressure kPa (PSI)			
TYPE			
RPM			
BHP			
Motor kW (HP)			
Impeller Size			
Volts/Phase			
Amps			
Comments:			

EXHAUST FAN			
EXHAUST FAN NUMBER		SPEC REFERENCE	
SYSTEM SERVED			
LOCATION			
EXHAUST FAN DATA	Specified	Shop Drawings	Installed
MANUFACTURER			
MODEL NUMBER			
CAPACITY L/S (CFM)			
STATIC PRESSURE KPA (IN.)			
FAN TYPE			
RPM			
BHP KW (HP)			
MOTOR KW (HP)			
RPM			
VOLTS/PHASE			
AMPS			
COMMENTS:			

Name	Position	Company	Signature

EXHAUST FAN							
EXHAUST FAN NUMBER				SPEC REFERENCE			
Pre Start-up Verification:	YES	NO	N/A		YES	NO	N/A
Ductwork installation complete				Unit cleaned			
Air filters installed				Wiring complete			
Filter gauges installed				Abnormal vibrations			
Lubrication complete				Rotation correct			
Speed drive installed				Isolation working			
Lights working				Drains connected			
Identification tags match spec.				Controls functional			
Mfgr's test sheets complete				Test sheets attached			
O/A damper closed with fan off				Safeties function			
COMMENTS: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____							

Name	Position	Company	Signature

EXHAUST FAN			
FAN NUMBER		SPEC NUMBER	
MANUFACTURER			
MODEL NUMBER			
SERIAL NUMBER			
LOCATION			
AREA SERVED			
TEST DATA	Design	Measured	Notes
Total Flow Fan L/S (cfm)			
Total Flow at Outlet			
Total External Static			
Discharge Pressure kPa (")			
Fan RPM			
MOTOR DATA			
FRAME			
Volts/Phase			
Amps			
RPM			
HP/KW			
COMMENTS:			

Name	Position	Company	Signature

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings; where required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba, Canada.
- .3 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .4 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .5 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with Contract Administrator before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

- .6 Approvals:
 - .1 Submit 1 copy of draft Operation and Maintenance Manual to Contract Administrator for approval. Submission of individual data will not be accepted unless directed by Contract Administrator.
 - .2 Make changes as required and re-submit as directed by Contract Administrator.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Contract Administrator will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of Work. Mark changes as Work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show Work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Contract Administrator for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

1.3 MAINTENANCE

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One gasket set for each heat exchanger.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

Part 2 Products (Not Used)

Part 3 Execution

3.1 PAINTING REPAIRS AND RESTORATION

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.

3.2 CLEANING

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

3.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 DEMONSTRATION

- .1 Contract Administrator will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:
 - .1 Heating, Ventilation and Air Conditioning (HVAC) Systems.
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular Work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Contract Administrator may record these demonstrations on video tape for future reference.

3.5 PROTECTION

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B139-04, Installation Code for Oil Burning Equipment.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.
- .4 National Fire Code of Canada (NFCC 2005)
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 Products

2.1 MATERIAL

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

Part 3 Execution

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

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

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and related codes.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 DRAINS

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

3.5 AIR VENTS

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

3.6 DIELECTRIC COUPLINGS

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

3.7 PIPEWORK INSTALLATION

- .1 Install pipework to CSA B149.
 - .2 Screwed fittings jointed with Teflon tape.
 - .3 Protect openings against entry of foreign material.
 - .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
 - .5 Assemble piping using fittings manufactured to ANSI standards.
 - .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
 - .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
 - .8 Install concealed pipework to minimize furring space, maximize headroom, and conserve space.
-

- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps.

3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for firestopping.
 - .2 Maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
-

- .2 Construction: one piece type with set screws.
 - .1 Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: outside diameter to cover opening or sleeve.
 - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fires topping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

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

3.13 EXISTING SYSTEMS

- .1 Connect into existing piping systems as indicated.
- .2 Be responsible for damage to existing plant by this Work.
- .3 Drain and re-fill existing hydronic heating system as required to facilitate tie ins. Conform to Section 23 08 02.

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: Work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.

1.5 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

2.1 GENERAL

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

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W (1/2 HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 208 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 Correct size of sheave determined during commissioning.
- .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .6 Motor slide rail adjustment plates to allow for centre line adjustment.
- .7 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

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

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 datasheet.

3.2 INSTALLATION

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

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

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International Inc.
 - .1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A105/A105M-05, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Manufacturer, model number, line contents, pressure and temperature rating.
 - .2 Movement handled, axial, lateral, angular and the amounts of each.
 - .3 Nominal size and dimensions including details of construction and assembly.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data in accordance with Section 01 78 00- Closeout Submittals.
 - .1 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 FLEXIBLE CONNECTION

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated.
- .3 Inner hose: stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: to match associated piping.
- .6 Operating conditions:
 - .1 Working pressure: 1034 kPa.
 - .2 Working temperature: from -40 °C to 107°C (-40 °F to 225°F)
 - .3 To match system requirements.

2.2 ANCHORS AND GUIDES

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

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Install expansion joints with cold setting. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.
- .4 Do welding in accordance with section 23 05 17- Pipe Welding.

3.3 PIPE CLEANING AND START-UP

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

3.4 PERFORMANCE VERIFICATION

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

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11- Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2007, Power Piping.
 - .2 ANSI/ASME B31.3-2006, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code-2007:
 - .1 BPVC 2007 Section I: Power Boilers.
 - .2 BPVC 2007 Section V: Non-destructive Examination.
 - .3 BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1M/C1.1-2000(R2006), Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-M1987(R2008), Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51-03(R2007), Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-2008, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-2008, Certification of Welding Inspectors.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

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

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

1.4 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 ELECTRODES

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

Part 3 Execution

3.1 APPLICATION

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

3.2 QUALITY OF WORK

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

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Contract Administrator before Work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Contract Administrator.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Contract Administrator.
-

- .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .3 Inspect and test welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests.
- .2 Hydrostatically test welds to ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Contract Administrator. Perform testing of up to 10 % of welds by particle test. Welds shall be selected at random by Contract Administrator.

3.6 DEFECTS CAUSING REJECTION

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

3.7 REPAIR OF WELDS WHICH FAILED TESTS

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

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 Products

2.1 GENERAL

- .1 Design point to be at mid-point of scale or range.
- .2 Ranges: 0-1100 kPa.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB-14.4.
 - .1 Resistance to shock and vibration.

2.3 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.

2.4 PRESSURE GAUGES

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
 - .1 Snubber for pulsating operation.
 - .2 Diaphragm assembly for corrosive service.
 - .3 Gasketed pressure relief back with solid front.
 - .4 Bronze stop cock.

Part 3 Execution

3.1 GENERAL

- .1 Install thermometers and gauges so they can be easily read from floor or platform.
 - .1 If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
 - .1 Heat exchangers.
 - .2 Water boilers.
- .3 Install wells for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in locations as follows:
 - .1 Suction and discharge of pumps.
 - .2 Upstream and downstream of PRV's.
 - .3 Inlet and outlet of liquid side of heat exchangers.
 - .4 Outlet of boilers.
 - .5 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

- .1 Install engraved lamicoïd nameplates identifying medium.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 01 33 00 - Submittal Procedures
- .2 01 78 00 - Closeout Submittals.
- .3 Mechanical drawings.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International
 - .1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat Treated.
 - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .3 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

Part 2 Products

2.1 SYSTEM DESCRIPTION

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

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated.
 - .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 13 mm FM approved.
 - .2 Cold piping NPS 2-1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58 and MSS-SP69.
 - .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.
 - .2 Cold piping NPS 2-1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
-

- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with two nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: black.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

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

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 164 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 300 and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with two springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops.
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 HOUSE-KEEPING PADS

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

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 datasheet.

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:

- .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
- .2 Bolt-tightening torques to industry standards.
- .3 Steel pipes: install below coupling or shear lugs welded to pipe.
- .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code and authority having jurisdiction.
- .2 Copper piping: up to NPS 1/2: every 1.5 m.
- .3 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .4 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 32	2.4 m	1.8 m
38	3.0 m	2.4 m
50	3.0 m	2.4 m
63	3.7 m	3.0 m
75	3.7 m	3.0 m
89	3.7 m	3.3 m
100	3.7 m	3.6 m
125	4.3 m	
150	4.3 m	
200	4.3 m	
250	4.9 m	
300	4.9 m	

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

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.

- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

3.7 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and requirements for the identification of new equipment, piping systems, ductwork, valves and controllers, including the installation and location of identification systems.
- .2 Related Sections:
 - .1 01 33 00 - Submittal Procedures
 - .2 01 74 11 - Cleaning.

1.2 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 SUBMITTALS

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
-

- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

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

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.
 - .2 Equipment in Mechanical Rooms: use size # 9.

2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 N/A

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Natural gas: to CSA/CGA B149.1.
 - .2 Propane gas: to CSA/CGA B149.1.
 - .3 Sprinklers: to NFPA 13.
 - .4 Standpipe and hose systems: to NFPA 14.

2.5 IDENTIFICATION OF PIPING SYSTEMS

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

- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Contract Administrator.
 - .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
White	BLACK

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

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Hot Water Heating Supply	White	HWS
Hot Water Heating Return	White	HWR
Glycol Heating Supply	White	GHS
Glycol Heating Return	White	GHR
Natural Gas	Yellow (Paint entire pipe according to codes)	

2.6 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.7 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.8 CONTROLS COMPONENTS IDENTIFICATION

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

2.9 EQUIPMENT

- .1 Identify all equipment with specified tags as indicated on drawings.

2.10 LANGUAGE

- .1 Identification in English.

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 datasheet.

3.2 INSTALLATION

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

3.3 NAMEPLATES

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

3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.

- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 VALVES, CONTROLLERS

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

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 SCOPE OF WORK

- .1 TAB of new circulation pumps (P-9, P-10).
- .2 TAB of hot water flow to new Heat Exchangers (HX-3 and HX-4).
- .3 TAB of new Air Handling Unit (F6 a / b – Test individual units as well as both units running).
- .4 TAB of exhaust fan F-15, including each branch of the exhaust system.
- .5 TAB of the new supply grille in the training room.
- .6 Refer to mechanical drawings for details. Coordinate Work with all applicable sections including section 230933 Electric and Electronic Control for HVAC

1.3 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Contract Administrator within 90 days of award of contract.
 - .2 Provide documentation confirming qualifications, successful experience.
 - .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
 - .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
 - .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
 - .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
 - .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
 - .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
-

- .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist. Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 PURPOSE OF TAB

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

1.5 EXCEPTIONS

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

1.6 CO-ORDINATION

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

1.7 PRE-TAB REVIEW

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

1.8 START-UP

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

1.9 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by Contract Administrator for verification of TAB reports.
-

1.10 START OF TAB

- .1 Notify Contract Administrator 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.11 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 5 %, minus 5%.
 - .2 Hydronic systems: plus or minus 10 %.

1.12 ACCURACY TOLERANCES

- .1 Measured values accurate to within plus or minus 2% of actual values.

1.13 INSTRUMENTS

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

1.14 SUBMITTALS

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

1.15 PRELIMINARY TAB REPORT

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

1.16 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit one copies of TAB Report to Contract Administrator for verification and approval, in English in electronic (PDF) format.

1.17 VERIFICATION

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

1.18 SETTINGS

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

1.19 COMPLETION OF TAB

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

1.20 AIR SYSTEMS

- .1 Standard: TAB to most stringent of TAB standards of AABC.
Do TAB of systems, equipment, components, controls specified Division 23.
- .2 Qualifications: personnel performing TAB current member in good standing of AABC.
- .3 Quality assurance: perform TAB under direction of supervisor qualified by AABC.
- .4 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .5 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .6 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.21 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to Work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Smoke management systems:
 - .1 Test for proper operation of all smoke and fire dampers, sensors, detectors installed as component parts of air systems specified Division 23.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 01 33 00 - Submittal Procedures
- .2 01 74 11 – Cleaning
- .3 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ASTM International Inc.
 - .1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .9 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
 - .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

- .6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .7 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.
 - .3 Manufacturers' Instructions:
 - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, and cleaning procedures.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing Work of this section, and have at least 3 years successful experience in this size and type of project.

1.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
 - .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
 - .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
-

- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

- .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .7 Contact adhesive: quick-setting
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .11 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
 - .2 Apply materials in accordance with manufacturers instructions and as indicated.
-

- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular and round ducts outside	C-1	yes	50
Supply, return and exhaust ducts exposed in space being served	none		
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Exhaust duct between dampers and louvers	C-1	no	25

- .2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

- .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

- .1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Insulation of all new and modified hydronic (water and glycol) piping, valves, strainers, etc.
- .2 Related Sections:
 - .1 01 33 00 - Submittal Procedures
 - .2 01 74 11 - Cleaning.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-2003, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- .1 Qualifications:
- .2 Installer: specialist in performing Work of this Section, and have at least 3 years successful experience in this size and type of project.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
 - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.
- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: to ASTM C533.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
 - .3 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

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

2.4 CEMENT

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

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

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

2.7 OUTDOOR VAPOUR RETARDER FINISH

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

2.8 JACKETS

- .1 **Indoor:** Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.

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 datasheet.

3.2 PRE-INSTALLATION REQUIREMENT

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

3.3 INSTALLATION

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

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

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

3.5 INSTALLATION OF ELASTOMERIC INSULATION

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

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Hot Water Heating	60 - 94	A-1	25	38	38	38	38	38

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Hot Water Heating	up to 59	A-1	25	25	25	25	38	38
Domestic HWS		A-1	25	25	25	38	38	38
Domestic CWS		A-3	25	25	25	25	25	25

.3 Finishes:

- .1 Indoors: PVC jacket.
- .2 In mechanical rooms: PVC jacket.
- .3 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- .4 Outdoors: water-proof aluminum jacket.
- .5 Finish attachments: SS bands, at 150 mm on centre.
- .6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 01 91 13 - General Commissioning (Cx) Requirements
- .2 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Boiler operation.
 - .3 Control pressure failure.
 - .4 Maximum heating demand.
 - .5 Boiler failure.
 - .6 Outdoor reset. Re-check boiler output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.

- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

1.6 REPORTS

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

1.7 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O&M Personnel.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
- .2 Related Sections:
 - .1 01 33 00 - Submittal Procedures
 - .2 01 74 11 - Cleaning
 - .3 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

2.1 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

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 datasheet.
-

3.2 CLEANING HYDRONIC SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of Work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .7 Repeat with water at design temperature.
 - .8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .9 Bring system up to design temperature and pressure slowly over a 48 hour period.
 - .10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .11 Adjust pipe supports, hangers, springs as necessary.
 - .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .13 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .14 Check operation of drain valves.
 - .15 Adjust valve stem packing's as systems settle down.
 - .16 Prior to start of TAB, fully open balancing valves (except those that are factory-set).
 - .17 Check operation of over-temperature protection devices on circulating pumps.
 - .18 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE OF WORK

- .1 Air Handling (Make Up Air) Unit (F-6A / B)
 - .1 Provide system of controls as per sequence of operations stated herein. Provide heating/cooling changeover based on outdoor air temperature.
 - .1 One unit shall operate continuously.
 - .1 Outdoor air damper fully open.
 - .2 Modulate three-way mixing control valve associated with outside air pre-heating coil to maintain 68°F discharge air to the main heating coil (set point to be operator adjustable).
 - .3 Supply air temperature setpoint shall be reset to based on outdoor air temperature between operator adjustable temperature set points.
 - .2 The second unit shall automatically start under the following conditions:
 - .1 When 4 or more of the existing heating boilers (B-1 to B-6) are operating.
 - .2 When the first unit fails. (Generate unit failure alarm and restrict heating boiler plant operation to 3 boilers.)
 - .3 DDC System shall duty cycle the units based on equal run time. Start the second unit prior to shutting down the operating unit.
 - .4 For each unit, DDC shall monitor the following:
 - .1 Supply Fan Status.
 - .2 Outdoor air temperature.
 - .3 Supply air temperature.
 - .4 Damper position.
 - .5 Control Valve position.
 - .6 Air filter differential pressure.
 - .5 DDC shall alarm the following:
 - .1 Supply Fan failures
 - .2 Damper Actuator failures.
 - .3 Control Valve failures.
 - .4 Low supply air temperature (Freezestat shutdown by Section 237311).
 - .5 High air filter differential pressure (Clogged filter).
 - .6 Control Valves: Supplied by Section 23 09 33 / Installed by Section 23 21 13.02.
 - .2 Boiler Interlock: Provide hardwired boiler interlock between the existing interlock system and the new units. Modify existing system to meet the following:
 - .1 Allow the two domestic water boilers (DWB-1/DWB-2) and up to three heating boilers to operate when air flow and damper opening is proven from one makeup air section (F-6a or F-6b).
 - .2 Allow the two domestic water boilers (DWB-1/DWB-2) and all six heating boilers to operate when air flow and damper opening is proven from both makeup air sections (F-6a or F-6b).
- .2 Glycol Circulation Pumps (P-9 and P-10):
 - .1 DDC System shall operate the pumps as follows:

- .1 One pump shall operate continuously.
 - .2 Second pump to remain stand-by.
 - .3 Provide start / stop / status of both pumps.
 - .4 Upon pump failure, DDC system shall automatically start stand-by pump and generate a pump failure alarm for the failed pump.
 - .5 DDC system shall provide duty cycling of the pumps based on run time.
- .3 Heat Exchangers (HX-3 and HX-4):
- .1 DDC shall monitor the following:
 - .1 Glycol loop supply and return temperatures.
 - .2 Hot water supply and return temperatures.
 - .2 DDC system shall alarm the following:
 - .1 Low glycol loop supply water temperatures.
- .4 Exhaust Fan F-15
- .1 Provide start/stop/status.
 - .2 Provide programmable schedule, operator adjustable.
 - .3 Damper Actuators: Supplied/Installed by Section 23 09 33. (Co-ordinate with Section 23 33 15).
 - .4 Operate fan as follows:
 - .1 Occupied mode: Fan ON
 - .2 Un-occupied Mode: Fan OFF
 - .5 Monitor damper position
 - .6 Alarm fan or damper failures.
- .5 There is an existing central monitoring system in place. All DDC points are identified as centrally monitored points. The Contractor shall provide and install required hardware and software to interface to the existing Johnson Controls Metasys EA servers and workstations. These are located at the Central Control Offices, 510 Main Street, Winnipeg, Manitoba. All new controls shall be provided by the manufacturer of the existing control system. The Contractor is required to meet with the City for additional direction.
- .6 Contractor to supply all drawings/graphics/sequence of operations in both a hard and soft copy. Drawings and graphics to be able to be read and modified by The City. User interface graphics to be completed using Graphic Generation Tool software. Graphics must use The City of Winnipeg graphic templates. Contractor to supply As-Built drawings in an editable format, able to be easily edited by The City.
- .7 BACnet Communication protocol shall be provided.
- .8 A complete list of setpoints for all controlled equipment shall be provided.
- .9 A points list is to be provided for all controlled objects
- .10 Alarm Messages: All objects that must be alarmed will have in the alarm message text the following information as per the included example. Alarm Message: Building Address, What is in alarm, see graphic for Instruction. Example: 251 Donald SF-1 VFD Common Alarm, see graphic for Instruction.

1.2 REFERENCES

- .1 ANSI/ASHRAE STANDARD 135-2010 BACnet—A Data Communication Protocol for Building Automation and Control Networks

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings and Product Data:
 - .1 Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
 - .2 Submit manufacturer's instructions, printed product literature and data sheets for electric and electronic control system for HVAC and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Shop Drawings, Product Data, and Samples
 - .1 The BMS Subcontractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.
 - .2 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Contract Administrator for Contract compliance.
 - .3 Allow 15 working days for the review of each package by the Contract Administrator in the scheduling of the total BMS Work.
 - .4 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Subcontractor where filing is necessary. Provide a copy of all related correspondence and permits to the Contract Administrator.
 - .5 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.
 - .1 The BMS Subcontractor shall correct any errors or omissions noted in the first review.
 - .2 At a minimum, submit the following:
 - .1 BMS network architecture diagrams including all nodes and interconnections.
 - .2 Systems schematics, sequences and flow diagrams.
 - .3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - .4 Samples of Graphic Display screen types and associated menus.
 - .5 Detailed Bill of Material list for each system

1.4 DELIVERY, STORAGE AND HANDLING

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

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

Part 2 Products

2.1 POWER SUPPLIES AND LINE FILTERING

- .1 Control transformers shall be CSA approved. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with CEC requirements. Limit connected loads to 80% of rated capacity.

2.2 FLOW SWITCHES

- .1 Flow-proving switches shall be either paddle or differential pressure type, as shown.
- .2 Differential pressure type switches (air or water service) shall be CSA approved, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.

2.3 ELECTRIC DAMPER/VALVE ACTUATORS

- .1 The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.
- .2 Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing.
- .3 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
- .4 All 24 VAC/VDC actuators shall operate on Class 2 wiring
- .5 All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 Nm (60 in.-lb) torque capacity shall have a manual crank for this purpose.

2.4 TEMPERATURE SENSORS

- .1 Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
- .2 Duct sensors shall be single point or averaging. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross section.
- .3 Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
- .4 Space sensors shall be equipped with set point adjustment, override switch, display, and/or communication port.
- .5 Provide matched temperature sensors for differential temperature measurement.

2.5 CONTROL VALVES

- .1 Control valves shall be two-way or three-way type for two-position or modulating service as shown.
-

- .2 Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - .1 Water Valves:
 - .1 Two-way: 150% of total system (pump) head.
 - .2 Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - .3 Water Valves:
 - .1 Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - .2 Sizing Criteria:
 - .1 Two-position service: Line size.
 - .2 Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - .3 Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.
 - .4 Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - .5 Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
 - .3 Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - .1 Water zone valves—normally open preferred.
 - .2 Heating coils in air handlers—normally open.
 - .3 Chilled water control valves—normally closed.
 - .4 Other applications—as scheduled or as required by sequences of operation.

2.6 RELAYS

- .1 Control relays shall be CSA approved plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
- .2 Time delay relays shall be CSA approved solid-state plug-in type with adjustable time delay. Delay shall be adjustable $\pm 200\%$ (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

2.7 LOCAL CONTROL PANELS

- .1 All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
- .2 Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be CSA approved for 600 volt service, individually

identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

- .3 Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.8 WIRING AND CONDUITS

- .1 General: Provide copper wiring and conduits as specified in the applicable sections of Division 26.
- .2 All wiring shall be run in conduits.
- .3 All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electric and electronic control systems installation in accordance with manufacturer's written instructions.

3.2 GENERAL WORKMANSHIP

- .1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .3 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .4 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.3 WIRING

- .1 All control and interlock wiring shall comply with the CEC and local electrical codes and Division 26 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
- .2 All CSA Class 1 (line voltage) wiring shall be CSA approved in approved raceway according to CSA and Division 26 requirements.
- .3 All low-voltage wiring shall meet CSA Class 2 requirements. (Low-voltage power circuits shall be sub fused when required to meet Class 2 current limit.)
- .4 Where CSA Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are CSA approved for the intended application. For example, cables used in ceiling plenums shall be CSA approved specifically for that purpose.
- .5 All wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage shall be installed in raceway at levels below 3 m (10 ft).
- .6 Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- .7 Do not install wiring in raceway containing tubing.
- .8 Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or

- perpendicular to it and *neatly* tied at 3 m (10 ft) intervals.
- .9 Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
 - .10 All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
 - .11 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
 - .12 Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the BMS Subcontractor shall provide step-down transformers.
 - .13 All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
 - .14 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
 - .15 Size of raceway and size and type of wire shall be the responsibility of the BMS Subcontractor, in keeping with the manufacturer's recommendations and CSA requirements, except as noted elsewhere.
 - .16 Include one pull string in each raceway 2.5 cm (1 in.) or larger.
 - .17 Use coded conductors throughout with conductors of different colors.
 - .18 Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
 - .19 Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).
 - .20 Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
 - .21 Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
 - .22 Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
 - .23 The BMS Subcontractor shall terminate all control and/or interlock wiring and shall maintain updated (asbuilt) wiring diagrams with terminations identified at the job Site.
 - .24 Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
 - .25 Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 00 - Closeout Submittals.
- .3 Section 23 05 17 - Pipe Welding.
- .4 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .5 Section 23 05 05 - Installation of Pipework.
- .6 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .7 Section 23 08 01 - Performance Verification of Mechanical Piping.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.
 - .5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
 - .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
 - .3 American Water Works Association (AWWA).
 - .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
-

- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67-025, Butterfly Valves.
 - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.4 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals.
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 MAINTENANCE

- .1 Extra Materials.
 - .1 Provide following spare parts:
 - .1 Valve seats: one for every ten valves, each size. Minimum one.
 - .2 Discs: one for every ten valves, each size. Minimum one.
 - .3 Stem packing: one for every ten valves, each size. Minimum one.
 - .4 Valve handles: two of each size.
 - .5 Gaskets for flanges: one for every ten flanges.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS 12: Schedule 40.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with Teflon tape.
- .2 NPS 2 1/2 and over: welding fittings and flanges to CSAW47.1 and CSA W47.1S1.
- .3 Flanges: raised face, weld neck.
- .4 Flange gaskets: to ANSI/AWWA C111/A21.11.
- .5 Bolts and nuts: to ANSI B18.2.1 and ANSI/ASME B18.2.2.
- .6 Pipe thread: taper.
- .7 *Grooved (Victaulic) connections are not permitted.*

2.3 FITTINGS

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

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2 ½ and larger: Flanged ends.
(Grooved connections not permitted)
- .2 Ball Valves:
 - .1 NPS 2 and under:
 - .1 To ASTM B62, 4 MPa WOG, bronze body, screwed ends, TFE seal, hard chrome solid ball, Teflon seats and lever handle.
 - .2 Acceptable product: Toyo Figure 5044A, Crane, Grinnell or approved equivalent in accordance with B7.
- .3 Gate valves:
 - .1 NPS 2 and under:
 - .1 Rising stem: to MSS SP-80, Class 125, 860 kPa, bronze body, solid wedge disc.
 - .2 Acceptable material: Toyo Fig 206A, Crane, Grinnell or approved equivalent in accordance with B7.
 - .2 NPS 2 ½ and over:
 - .1 Rising stem, OS & Y, bolted bonnet, solid wedge, disc flanged end, to MSS SP-70, cast iron body bronze trim.
 - .2 Acceptable material: Toyo Fig No. 421A, Crane, Grinnell or approved equivalent in accordance with B7.
- .4 Balancing Valves:
 - .1 NPS 2 and under:

Threaded bronze body construction, brass ball, TFE seat rings c/w memory stop, and differential pressure readout ports.

Acceptable Product: "Bell & Gossett" model CB or approved equivalent in accordance with B7.
 - .2 NPS 2 ½ and over:
 - .1 flanged cast iron body construction, c/w memory stop, and differential pressure readout ports.
 - .3 Acceptable Product: "Armstrong" Model: CBV-FS or approved equivalent in accordance with B7.
- .5 Check Valves:
 - .1 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 Standard specification: MSS SP-80.
- .6 Control Valves: Supplied by Section 23 09 33 / Installed by Section 23 21 13.02.

Part 3 Execution

3.1 PIPING INSTALLATION

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

3.2 CIRCUIT BALANCING VALVES

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

3.3 CLEANING, FLUSHING AND START-UP

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

3.4 TESTING

- .1 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.5 BALANCING

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

3.6 GLYCOL CHARGING

- .1 Provide mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.

3.7 PERFORMANCE VERIFICATION

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME-04(2007), Boiler and Pressure Vessel Code.
- .2 ASTM International Inc.
 - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M-01(2006), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536-84(2004), Standard Specification for Ductile Iron Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B51-03(R2003), Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CSA B51-03(R2005), Boiler, Pressure Vessel, and Pressure Piping Code, Supplement #1.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 EXPANSION TANK (EXP-1)

- .1 Tank volume: 168 L (44.4 gal), acceptance volume: 85 L (22.6 gal), 413 mm (16.25 inch) diameter, 1422 mm (56 inch) height.
 - .2 Pre-charged steel expansion tank, 115°C (240°F) working temperature, stamped with 862 kPa (125 PSI) working pressure. Tank will be supplied with a heavy duty butyl diaphragm, ring base, lifting rings, and 12.7mm (½) NPT system connection. An air charging valve shall be provided to facilitate adjusting pre-charge pressure to meet actual system conditions. ASME rated.
 - .3 Acceptable Product: "Bell & Gossett" Model: DV-80 approved equivalent in accordance with B7.
-

2.2 HYDRONIC SYSTEM FEEDER (HSF-1)

- .1 Re-use existing hydronic system feeder shall be from existing system.

2.3 AIR VENTS

- .1 Automatic air vent suitable for hot water heating system with brass body and high temperature resistant polyethylene float.
- .2 Acceptable Product: "Watts" model FV-4M1 or approved equivalent according to B7.

2.4 AIR SEPARATOR, AS-1

- .1 75 mm (3") Flanged inlet and outlet connections, Diameter: 218 mm (8.6"), Height: 602 mm (23.7"), Dry Weight: 43.2 kg (95 lb), steel shell, brass skim valve, brass/non-ferrous air vent.
- .2 Coalescing type air eliminator for hot water systems. Rated for 1034 kPa (150 PSI) working pressure, and stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels. The elements shall consist of a copper core tube with continuous wound copper wire medium. Separate venting chamber to prevent system contaminants from harming the float actuated brass venting system. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
- .3 Acceptable Product: "Spirotherm" model VSR300 or approved equivalent according to B7.

2.5 STRAINER

- .1 1/2 NPS to 2 NPS: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 2-1/2 NPS to 12 NPS: cast steel body to ASTM A278/A278M, Class 30, flanged connections.

2.6 CHEMICAL POT FEEDER

- .1 7.6 L (2 gal) pressure vessel volume. 19 mm (3/4") NPT connections. System shall include carbon steel chemical bypass feeder, and 600 mL polyethylene graduated funnel with integral 20 mesh strainer. 1.14 MPa (165 PSI) maximum pressure.
- .2 Acceptable Product: "Axiom" model CBF-2 or approved equivalent in accordance with B7.

2.7 SIDESTREAM FILTER PACKAGE

- .1 System shall include filter, sight flow indicator, ball valve, balancing valve, and nipples. Suitable for flow rates from 0-38 L/s (0-10 USGPM).
- .2 Filter shall be constructed of 304 stainless steel filter housing with brass head and shall include two EPDM o-rings, brass drain valve with barb fitting and cap, and filter cartridge shall be a cotton wound filter cartridge with stainless steel core (25 micron). Filter housing length shall be 250 mm (10"). 1.5 L (0.4 gal) vessel volume.
- .3 Sight flow indicator has brass body and shall include EPDM o-rings, two tempered borosilicate glass windows, 304 stainless steel cage, TPX ball, and cork washers (non-wetted part).
- .4 Ball valve shall be of brass construction.

- .5 Manual balancing valve shall be of brass construction and comes with an integral air vent, memory stop, and shall be able to provide flow metering, flow balancing, and filter cartridge isolation.
- .6 Three brass nipples shall each be 75 mm (3") in length.
- .7 19 mm (3/4") FNPT connections. 860 kPa (125 PSI) maximum pressure, 93°C (200°F) maximum temperature. Compatible with water and propylene glycol in concentrations up to 50%.
- .8 Acceptable Product: "Axiom" model SFP-10-25M or approved equivalent in accordance with B7.

2.8 RELIEF VALVE:

- .1 435 kW (4,900,000 BTUH) relief capacity at 3.5 bar (50 PSI) relief setting, 38 mm (1-1/2") NPT inlet, 50mm (2") NPT outlet, ASME Section IV construction, iron body. 121°C (250°F) maximum operating temperature. Valve capacity shall exceed the full heating capacity of the system it is being installed in.
- .2 Dimensions (HxW): 279 mm x 152 mm (11" x 6"). Weight: 7.7 kg (17 lb).
- .3 Acceptable Product: "Bell & Gossett" model 3301 or approved equivalent in accordance with B7.

Part 3 Execution

3.1 APPLICATION

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

3.2 GENERAL

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

3.3 STRAINERS

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

3.4 AIR VENTS

- .1 Install at high points of systems.
 - .2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain.
-

3.5 EXPANSION TANKS

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

3.6 PRESSURE SAFETY RELIEF VALVES

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC)
- .3 Canadian Standards Association (CSA International)
 - .1 CSA-B214-07, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers' Association (NEMA)
 - .1 NEMA MG 1-2006, Motors and Generators.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 MAINTENANCE

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 GLYCOL CIRCULATION PUMPS (P-9 AND P-10)

- .1 Capacity: 4.5 L/s (72 usgpm) against total differential head of 96 kPa (31 ft. of Head.), 1.1 BHP at design.
 - .2 Fluid: 50% Propylene Glycol
 - .3 Impeller: 158 mm (6.25")
 - .4 Connections: 38 mm (1.5") Flanged, flange to flange distance 346 mm (13.5").
 - .5 Construction:
 - .1 Close coupled vertical inline centrifugal pump.
 - .2 Pump casing shall be constructed of ASTM A48 class 30 cast iron with ANSI 125 / PN16 flanges. Maximum working pressure 12 bar (175 psig), maximum working
-

- temperature at 107°C (225°F). The casing shall be hydrostatically tested to 150% maximum working pressure. The casing shall be radially split to allow removal of the rotating element without disturbing the pipe connections.
- .3 Pump impeller shall be fully enclosed type. The impeller shall be keyed and secured to the pump shaft by stainless steel fittings.
 - .4 The pump shaft shall be a stainless steel stub shaft for frame 56 motors. The steel motor shaft shall be enclosed by a bronze shaft sleeve, on other motor frame sizes.
 - .5 Mechanical Seal shall be single spring inside type with Carbon and Ceramic faces, EPDM elastomer, stainless steel spring and hardware. Provide factory installed seal vent line, piped from the seal area to the pump suction connection.
 - .6 Motor: 1.11 kW (1.5 HP), 575/3/60, 1800 RPM, ODP with NEMA Premium Efficiency rating, motor shall be non-overloading at any point on the impellor curve.
 - .7 Weight: 40 kg (89 lb).
 - .8 Acceptable product: "Bell & Gossett" 1.5AB Series e-90 c/w suction diffusers and triple duty valves or approved equivalent in accordance with B7.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Install hydronic pumps to: CSA-B214.
- .2 Provide pipe modifications and new flanges as required to match pump. Replace pipe insulation as required.
- .3 In line circulators: install as indicated by flow arrows.
 - .1 Support at inlet and outlet flanges or unions.
 - .2 Install with bearing lubrication points accessible.
- .4 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
- .5 Ensure that pump body does not support piping or equipment.
 - .1 Provide stanchions or hangers for this purpose.
 - .2 Refer to manufacturer's installation instructions for details.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.3 START-UP

- .1 General:

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx)
Requirements: General Requirements; supplemented as specified herein.
- .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
 - .4 Check base for free-floating, no obstructions under base.
 - .5 Run-in pumps for 12 continuous hours minimum.
 - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .7 Eliminate air from scroll casing.
 - .8 Adjust water flow rate through water-cooled bearings.
 - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .10 Adjust alignment of piping and conduit to ensure true flexibility.
 - .11 Eliminate cavitation, flashing and air entrainment.
 - .12 Adjust pump shaft seals, stuffing boxes, glands.
 - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
 - .15 Verify lubricating oil levels.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
 - .1 ASTM A653/A653M-09b, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process. (Metric).
- .3 Green Seal Environmental Standards (GS)
 - .1 GS-36-11, Standard for Adhesives for Commercial Use.
- .4 Sheet Metal Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2005.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
 - .3 SMACNA IAQ Guideline for Occupied Buildings Under Construction, 2007.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00- Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Test and Evaluation Reports:
 - .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 DUCTWORK

- .1 Ductwork shall be constructed to maximum static pressure that the associated fans can produce.
- .2 Material:
 - .1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.
 - .2 Thickness: to SMACNA.
- .3 Construction: round.
 - .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
 - .2 Transverse joints up to 900 mm: slip type with tape and sealants.
 - .3 Transverse joints over 900 mm: Vanstone.
 - .4 Fittings:
 - .1 Elbows: smooth radius. Centreline radius: 1.5 times diameter.
 - .2 Branches: conical transition with conical branch at 45 degrees and 45 degrees elbow.
- .4 Construction: rectangular:
 - .1 Ducts: to SMACNA.
 - .2 Transverse joints: SMACNA seal Class A and B.
 - .3 Fittings:
 - .1 Elbows: smooth radius; centreline radius 1.5 times width of duct. No vanes.
 - .2 Branches: with conical branch at 45 degrees and 45 degrees elbow.
- .5 Fire stopping:
 - .1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation.
 - .2 Fire stopping material must not distort duct.

2.2 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure (Pa)	SMACNA Seal Class
2500	A
1500	A
1000	A
750	B

- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

2.3 SEALANT

- .1 Oil resistant, water-borne polymer type flame resistant high velocity duct sealing compound.
 - .1 Temperature range of minus 40 degrees C to plus 93 degrees C.

2.4 TAPE

- .1 Tape: polyvinyl treated, open weave fibre glass, 50 mm wide.

2.5 HANGERS AND SUPPORTS

- .1 Hangers and supports: in accordance with Section 23 05 29- Hangers and Supports for HVAC Piping Equipment.

- .1 Band hangers: use on round and oval ducts up to 500 mm diameter, of same material as duct but next sheet metal thickness heavier than duct.
- .2 Trapeze hangers: ducts over 500 mm diameter or longest side, to SMACNA.
- .3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA and following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

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

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.

3.2 HANGERS

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

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.3 SEALING AND TAPING

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

3.4 LEAKAGE TESTS

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Perform leakage tests in sections.
- .3 Perform trial leakage tests, as instructed to demonstrate quality of Work.
- .4 Do not install additional ductwork until trial tests have been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .6 Complete tests before performing insulation or concealment Work.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11- Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11- Cleaning.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturer's Field Reports: manufacturer's field reports specified.
- .7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 GENERAL

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material:
- .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

2.3 ACCESS DOORS IN DUCTS

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
- .1 Up to 300 x 300 mm: two sash locks.
- .2 301 to 450 mm: four sash locks complete with safety chain.
- .3 451 to 1000 mm: piano hinge and minimum two sash locks.
- .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.

2.4 TURNING VANES

- .1 Factory or shop fabricated to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.
-

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 data sheet.

3.2 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
 - .1 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 At inlet and outlet of coils.
 - .3 Downstream of junctions of two converging air streams of different temperatures.
 - .4 And as indicated.
- .4 Turning vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 CLEANING

- .1 Perform cleaning operations as specified in Section 01 74 11 - Cleaning and in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Operating dampers for mechanical forced air ventilation and air conditioning systems.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate the following:
 - .1 Performance data.
- .3 Closeout Submittals
 - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Operation and Maintenance Data: submit operation and maintenance data for operating dampers for incorporation into manual.

Part 2 Products

2.1 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, as indicated.

2.2 INSULATED MOTORIZED DAMPERS (MD)

- .1 Size: 700mm x 700mm (28" x 28")
- .2 Dampers shall be parallel blade action.
- .3 Operator: by Section 23 09 33 – Electric and Electronic Control for HVAC.
- .4 Extruded aluminum (6063-T5) damper frame shall not be less than 2 mm in thickness. Damper frame shall be 100 mm deep x 25 mm, with duct mounting flanges on both sides of frame. Damper frame shall have a 50 mm mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners.

- .5 Blades shall be maximum 155 mm deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 1.5 mm. Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.
- .6 Blade seals shall be extruded EPDM, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.
- .7 Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.
- .8 Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 11 mm aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.
- .9 Hexagonal control shaft shall be 11 mm. It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.
- .10 Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage. Linkage that consists of metal rubbing metal will not be approved.
- .11 Dampers shall be designed for operation in temperatures ranging from -40°C to 100°C.
- .12 Dampers shall be AMCA rated for Leakage Class 1A at 250 Pa static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
- .13 Dampers shall be custom made to required size, with blade stops not exceeding 32 mm in height.
- .14 Dampers mounting type: Flanged to Duct.
- .15 Installation of dampers must be in accordance with manufacturers current installation guidelines, provided with each damper shipment.
- .16 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.
- .17 Acceptable Product: "Tamco" Series 9000 Thermally Insulated Damper or approved equivalent in accordance with B7.

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 datasheet.

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories and hardware for commercial use.

1.2 REFERENCES

- .1 Air Conditioning and Mechanical Contractors (AMCA)
 - .1 AMCA Publication 99-2003, Standards Handbook.
 - .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
 - .2 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

- .3 Provide :
 - .1 Fan performance curves showing point of operation, BHP and efficiency.
 - .2 Sound rating data at point of operation.
- .4 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
- .5 Closeout Submittals:
 - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Operation and Maintenance Data: submit operation and maintenance data for HVAC fans for incorporation into manual.

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide the following maintenance materials:
 - .1 Spare parts to include:
 - .1 Matched sets of belts.

Part 2 Products

2.1 FANS GENERAL

- .1 Motors:
 - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - .2 Sizes as specified.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .6 Vibration isolation: as per manufacturer's requirements.
- .7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 EXHAUST FAN (F-15)

- .1 Performance: 2735 L/s @ 225 Pa (5800 CFM @ 0.9" w.g.), 758 Fan RPM, 1.34 BHP.
- .2 Motor: 575V/3ph/60hz, 2 HP, 1725 RPM, TEFC enclosure, premium efficiency, permanently lubricated. FLA: 2.7 Amps
- .3 Belt drive mixed flow inline fan, bolted galvanized steel housing, flow straightening vanes, adjustable motor plate utilizing threaded studs for positive belt tensioning, integrated lifting lugs, ball bearings with extended lubrication lines, belt guard, bolted access door, phenolic epoxy powder coating, motor cover, spring ceiling mounted vibration isolators.

- .4 Dimensions(HxWxL): 1451 mm x 803 mm x 1067 mm (57-1/8" x 31-5/8" x 42") . Weight: 205 kg (452 lb).
- .5 Sound rating not to exceed 60 dBA at inlet, and 61 dBA at outlet.
- .6 Acceptable Product: "Cook" model 245TMX or approved equivalent in accordance with B7.

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 datasheet.

3.2 FAN INSTALLATION

- .1 Install fans as indicated, complete with resilient mountings, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Heat exchangers shall be compatible with chlorinated swimming pool water.
- .2 Provide one spare set of gaskets for each heat exchanger.

1.2 REFERENCES

- .1 CSA International
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 WATER TO GLYCOL HEAT EXCHANGERS (HX-3 & HX-4)

- .1 Design

- .1 To reduce installation and maintenance cost, units should be designed as single pass units unless thermal and hydraulic conditions require multi-pass arrangement.
 - .2 For single pass units all connections should be located on the fixed head, frame plate, allowing the movable head, pressure plate, to slide back and plates added, removed, or replaced from the plate pack without disturbing the connections or associated piping.
 - .3 The design should allow for the removal of interior plates without the removal of the plates.
 - .4 The unit shall be provided with an aluminum or stainless steel OSHA splash shield.
 - .5 The unit shall be designed, hydro-tested, and U-1 stamped in accordance with ASME Section VIII Division 1.
- .2 Frame
- .1 The frame plate and pressure plate should be carbon steel SA 516 grade 70.
 - .2 The frame and pressure plate shall be of sufficient thickness to meet the ASME design pressure. Stiffeners or support brackets are not allowed.
 - .3 Carbon steel frame components shall be painted with gray epoxy paint.
 - .4 Units with 3-inch or greater connections shall be unlined or alloy lined studded ports to mate with raised face or flat faced ANSI flanges. Rubber liners are not allowed.
 - .5 Units with 2 or 2 1/2-inch connections shall have carbon steel female tapped NPT or male NPT connections if an alloy material is required.
 - .6 Units with 1-inch ports shall have carbon steel or 316 stainless steel female tapped NPT or alloy material male NPT connections.
 - .7 Units with connections greater than 50mm (2-inch) require that the thermal plates be supported by the carry bar, top bar. The guide bar, bottom bar, shall only help properly align the plates.
 - .8 The pressure plate shall be supported by a roller assembly from the carry bar for units with 65mm (2 1/2-inch) or greater port sizes.
 - .9 The carry and guide bar plate contact surfaces shall be corrosion resistant.
 - .10 The design for units with 2-inch connections or smaller allow the plates be supported by the guide bar, bottom bar, and the carry bar, top bar, shall help properly align the plates. Carry and guide bars are to be steel with a zinc chromate coating.
- .3 Tightening Bolts
- .1 Tightening bolts shall be zinc plated carbon steel SA193 B7.
 - .2 The tightening bolt assemblies shall include captive working nuts at the pressure plate, rear head, such that the unit can be opened and closed with one wrench from the front of the unit.

- .4 Plates
 - .1 Plates shall be pressed in a one step stamping process.
 - .2 Plates shall use an integral rolled edge hanging system to provide a rigid hanger device between the plate and carry bar and guide bar. Welded on hanging brackets or stiffeners are not acceptable.
 - .3 The plate pack shall use a positive plate to plate alignment system to ensure proper plate to gasket seals throughout the plate pack. The positive alignment system shall either be a gasket lug which fits within a plate recess on the proceeding plate (tongue in groove) to align successive plates or an extended rolled edge hanger which nests successive plates through direct contact around the entire plate hanger. Plate designs, which only offer alignment through contact with the carry and guide bar, are unacceptable.
 - .4 Plates shall be permanently marked to indicate plate material and thickness.
 - .5 Gaskets
 - .1 All gaskets except the gasket on the first plate shall be identical.
 - .2 The gaskets shall be a one-piece construction with a double gasket barrier at the port region. The area isolated by the double gasket shall be vented to the atmosphere, so that a gasket failure is detected by leakage to the exterior prior to any possible cross contamination.
 - .3 Gasket attachment methods, which break during gasket removal or plate maintenance thus destroying the gasket, are not allowed.
 - .4 Care should be taken in the selection of gasket materials to insure compatibility with the fluids and operating temperatures.
 - .6 Selection, Certification and Testing
 - .1 The manufacturer shall provide written guarantee to the accuracy of the heat exchanger thermal design.
 - .2 The manufacturer shall be certified with the Air-Conditioning and Refrigeration Institute's Liquid to Liquid Heat Exchanger Certification program ARI Standard 400 for the Model being supplied.
 - .3 Should the Heat Exchanger not perform to the specified conditions as defined in the ARI Standard 400, the manufacturer is responsible to replace or repair the exchanger to achieve the stated performance.
 - .4 If the manufacturer is not certified with the Air-Conditioning and Refrigeration Institute's Liquid to Liquid Heat Exchanger certification program ARI Standard 400, a witnessed factory performance test must be completed per the testing specification of ARI 400.
 - .7 Acceptable Product: "Bell and Gossett" model GPX P20 or approved equivalent in accordance with B7.
 - .8 Heat Exchanger Schedule:
-

TAGS: HX-3 / HX-4		
	COLD SIDE	HOT SIDE
FLUID CIRCULATED	50% PG	Boiler Water
TOTAL FLUID ENTERING	4.54 L/s (72.0 gpm)	4.14 L/s (65.7 GPM)
PRESSURE DROP	31 kPa (4.5 PSI)	26 kPa (3.8 PSI)
TEMPERATURE IN	37.8°C (100 °F)	71.1°C (160 °F)
TEMPERATURE OUT	60.0 °C (140 °F)	48.9°C (120.0°F)
HEAT EXCHANGED	379 kW (1,293,863 BTUH)	
LMTD	20.0	
CONSTRUCTION:		
DESIGN PRESSURE	1034 kPa (150 PSI)	
TEST PRESSURE	1344 kPa (195 PSI)	
DESIGN TEMPERATURE	140 °C (284°F)	
PLATE MATERIAL	316 Stainless Steel	
NO. OF PLATES	34	
PLATE THICKNESS (mm)	0.5	
GASKET MATERIAL:	Nitrile HT	
CONNECTIONS:		
in	50mm (2" NPT)	50mm (2" NPT)
out	50mm (2" NPT)	50mm (2" NPT)
WEIGHT:	139 kg (427 lbs) empty 208 kg (459 lbs) flooded	
CODE REQUIREMENTS:	ASME Sect VII Div. 1 w/ stamp	
DIMENSIONS (HxWxL):	400 mm (L) x 308 mm (W)x 1067 mm. (H)	
NOTES:	Heat exchangers shall be designed to accommodate pressure difference between hot and cold sides.	

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 APPURTENANCES

- .1 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests and Inspections:
 - .1 Perform tests as directed by Contract Administrator to ensure heat exchangers are functional.
 - .2 Obtain reports within 3 days of review and submit immediately to Contract Administrator.
- .2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
- .3 Manufacturer's Field Services:
 - .1 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .2 Ensure manufacturer's representative is present before and during testing.

3.5 SYSTEM START-UP

- .1 General: perform start-up operations in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- .2 Check heater for cleanliness on primary and secondary sides.
- .3 Check water treatment system is complete, operational and correct treatment is being applied.
- .4 Check installation, settings, operation of relief valves and safety valves.
- .5 Check installation, location, settings and operation of operating, limit and safety controls.
- .6 Check supports, seismic restraint systems.
- .7 General: perform performance verification in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.
- .8 Timing: only after TAB of hydronic systems have been successfully completed.
- .9 Primary side:

- .1 Measure flow rate, pressure drop, and water temperature at heater inlet and outlet.
- .2 Control valve: verify proper operation without binding, slack in components. Measure if control is three-port type, pressure drop across inlet to common, bypass to common, inlet to bypass.
- .3 Secondary side:
 - .1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
- .4 Calculate heat transfer from primary and secondary sides.
- .5 Simulate heating water temperature schedule and repeat above procedures.
- .6 Verify settings, operation, safe discharge from safety valves and relief valves.
- .7 Verify settings, operation of operating, limit and safety controls and alarms.
- .8 Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.7 DEMONSTRATION

- .1 Training: provide training in accordance with Section 01 79 00 – Demonstration and Training.

3.8 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SCOPE

- .1 Supply, delivery, receiving, installation, and commissioning of the air handling unit specified herein.
- .2 Custom unit with two stacked sections is required.
- .3 Unit shall be designed to operate in high humidity swimming pool environment with air borne chlorine (or chlorine compounds). Any stainless steel components used in the unit shall be 316 or higher grade.

1.2 REFERENCES

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 430-99(R2002), Central-Station Air-Handling Units.
- .2 American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 90.1-2007, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ANSI/ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-07, Environmental Standard for Paints.
- .5 Master Painters Institute (MPI)
 - .1 MPI-INT 5.3-2007, Galvanized Metal.
- .6 South Coast Air Quality Management District (SCAQMD), California State (SCAQMD)
 - .1 SCAQMD Rule 1113-04, Architectural Coatings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for insulation, filters, adhesives, and paints, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following: fan, motor drive, voltage, total and sensible cooling, filters, mixing box, dampers, coil; include performance data.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide five spare sets of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

Part 2 Products

2.1 MAKE UP AIR UNIT (F-6 a/b)

- .1 General
 - .1 Make Up Air Units shall be built to the level of quality as herein specified and to the description of the Make Up Air Unit Schedule.
 - .2 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.
 - .3 Unless stated otherwise, make up air units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close proximity to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL, ETLUS, UL, CSA prior to shipment.
 - .4 Pre-wired make up air units shall bear an approved label with all the necessary identification marks, electrical data.
 - .5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.
 - .6 The make up air units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.
- .2 Unit Construction:
 - .1 Unit casing shall be of minimum 1.3mm (18 gauge) satin coat galvanized sheet metal.
 - .2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
 - .3 The entire airstream shall be provided with a 0.85mm (22 gauge) solid galvanized metal liner over insulated areas. Provide metal liner on underside of unit.
 - .4 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and access plenums. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
 - .5 Units shall be provided hinged access doors, with e-profile gasket, fully lined, and a minimum of two lever handles, operable from both sides for all units.

- .6 All units shall be internally insulated with 51mm (2") thick 48 kg./cu.m. (3 lb./cu.ft.) density insulation.
 - .7 48 kg/cu.m (3 lb./cu.ft.) insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.
 - .8 The floor is to act as drain pan (Wash down interior) complete with 51mm (2") upturn standing seams around perimeter (or 51mm (2") perimeter collar continuously welded to the unit base) and welded corners to ensure the floor is watertight. Alternately screwing down, tack welding and caulking of this collar is not acceptable. Provide 38mm (1 1/2") drain connections for complete drainability of the base pan.
 - .9 For swimming pool applications the following specialized construction and features for make up air units shall be provided:
 - Inlet and relief with openings on opposite sides of unit.
 - 120mm (4") Drain pan in mixing section.
 - Motors to be TEFC Super-E with 1.15 service factor.
 - Blower and motor drive belts shall have a 1.5 service factor.
 - Solid liner throughout unit interior.
 - Two part epoxy coat interior and exterior including blowers and damper blades.
 - Heresite coat coils in units with fluid heating and/or cooling.
 - Coat fan shafts with chlorine resistant coating.
 - Gasket and/or caulk seal all opening between control panel and the air stream.
- .3 Fans:
- .1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.
 - .2 Single low pressure forward curved fans shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.
 - .3 Fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
 - .4 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.
 - .5 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
 - .6 Provide single 316 SS extended grease line from far side to access side bearing.
 - .7 Fan motors shall be TEFC (totally enclosed fan cooled) Super E high efficiency type.
-

- .4 Coils:
- .1 Coils shall be 5/8" O.D., constructed of copper tube, aluminum fin, and copper headers with schedule 40 steel pipe connectors.
 - .2 Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.
 - .3 Headers shall be outside the make up air unit for maximum serviceability except for blow through applications where headers are internal. The non-headered end of the coil shall be fully concealed. Provide auxiliary drain pan complete with ½" (13mm) MPT drain connection at headered end of cooling coils.
 - .4 All water coils shall be equipped with a capped vent tapping at the top of the return header or connection, and a capped drain tapping at the bottom of the supply header or connection.
 - .5 Water and glycol coils shall be circuited to provide adequate tube velocities to meet design requirements. Internal turbulators are not acceptable.
 - .6 5/8" O.D. tube diameter water coils shall be ARI Certified.
 - .7 Provide Heresite P-413C, a pure phenolic with plasticizers thermosetting resinous coating to protect the coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing. Salt spray tested to ASTM-B-117 standards.
- .5 Filters:
- .1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.
 - .2 The filter modules shall be designed to slide out of the unit. Side removal 50mm (2") filters shall slide into a formed metal track of 316 Stainless Steel, sealing against metal spacers at each end of the track.
 - .3 50mm (2") Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Permanent re-usable metal enclosing frame. The filter media shall have a minimum efficiency of 30-35% on ASHRAE Standard 52.1-92, and a minimum of MERV 8 per ASHRAE 52.2. Rated U.L. Class 2.
 - .4 Filter media shall meet UL Class 2 standards.
- .6 Dampers:
- .1 Damper frames shall be U-shaped galvanized metal sections securely screwed or welded to the make up air unit chassis. Pivot rods of 13mm (1/2") aluminum shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.
 - .2 Blades shall be 1.3mm (18 gauge) galvanized metal with two breaks on each edge and three breaks on centerline for rigidity. The pivot rod shall "nest" in the

- centerline break. Damper edges shall interlock. Maximum length of damper between supports shall be 1219 mm (48"). Damper linkage brackets shall be constructed of galvanized metal.
- .3 Inlet dampers shall be extruded aluminum, low leak, thermally broken, insulated blade TAMCO Series 9000.
 - .4 Two position inlet dampers shall be parallel blade type.
- .7 Factory Supplied Controls/Wiring
- .1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.
 - .2 Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure, this device will shut down the fan and close the outdoor air damper.
 - .3 Start/Stop contact for supply blower to be wired to a terminal strip.
 - .4 Provide damper end switches wired to a terminal strip for status to Boiler Interlock system.
- .8 Make up air unit vendor shall provide on-site support to the BMS Subcontractor during commissioning of the control system.
-

.9 Schedules:

MAKE UP AIR UNIT SCHEDULE			
FAN NO.		F-6 a	F-6 b
MANUFACTURER		Engineered Air	
MODEL		LM3-C	
SUPPLY	Flow rate:	2,500	2,500
	ESP ("WC):	1.5	1.5
	MOTOR (HP):	1.9 / 3.0	1.9 / 3.0
	BLOWER:	10/10	10/10
HEATING	EAT / LAT (°F):	-30 / 74.5	-30 / 74.5
	EWT /LWT (°F):	140 / 103 (50% P.G.)	140 / 103 (50% P.G.)
	TOTAL (MBH):	282	282
TOTAL STACKED UNIT WEIGHT:		907 kgs (2000lbs)	
OVERALL STACKED UNIT DIMENSIONS (L x W x H):		1651mm x 1066mm 1651mm (65" x 42" x 65")	
REMARKS:		Performance data listed in this table is per section of the make up air unit.	

.10 Heating Coil Schedule:

Coil Tag	HC-1&2
Service	Heating
Tube Size (Outside Diameter) (mm / in.)	5/8" (16 mm) OD
Fin Surface	Corrugated - 0.0065"
Coil Size (mm / in.) (HxLxRxFPI)	608 x 914.5 x 3 / 12 24 x 36 x 3 / 12
Pass-Circ-Blank	12 - 4 - 0
Header Size (mm / in.)	38 / 1.5
Header Conn.	Same
Total Capacity (kW / MBH)	82.67 (282.15)
Sensible Capacity (kW / MBH)	82.67 (282.15)
Air Flow Conditions	Standard CFM
Airflow (L/s / CFM)	1180.0 / 2500
Air EDBT (°C / °F)	-34.4 / -30.0
Air LDBT (°C / °F)	23.6 / 74.5
Leaving Coil Velocity (m/s / AFPM)	2.19 / 431
Coil Pressure Drop (Pa / in.w.c.)	61.2 / 0.25
Fluid	P-Glycol (50%)
Entering Temperature (°C / °F)	60.0 / 140.0
Leaving Temperature (°C / °F)	38.1 / 100.6
Flow Rate (L/s / GPM)	1.011 / 16.0
Fouling factor allowance	0.0001
Tube Velocity (m/s / FPS)	1.33 / 4.4
Pressure Drop (kPa / ft.w.c.)	29.6 / 9.9
Notes:	<p>Fluid inlet and outlet connections are located on the same end.</p> <p>Units come as a stacked configuration for redundant operation as required.</p>

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Provide appropriate protection apparatus.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 Ensure adequate clearance for servicing and maintenance.

3.3 FANS

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2.
 - .3 CAN/CSA-C22.3 No. 1, Overhead Systems.
 - .4 CAN3-C235-83, 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.

1.2 ELECTRICAL SUBCONTRACTOR REQUIREMENTS

- .1 Comply with all Department of Labour, Workplace and Health requirements at all times.
 - .2 All Subcontractors shall have a valid license to operate in the City of Winnipeg.
 - .3 The complete installation shall be carried out in neat and workmanlike manner to the satisfaction of the Contract Administrator.
 - .4 All Electrical Subcontractor employees on Site shall have valid Trade Licenses.
 - .5 Electrical Subcontractor shall maintain the appropriate ratio of Journeymen Electricians & Apprentices required by Provincial Codes. Only qualified workmen shall be employed on this contract. Supervision shall be by Journeymen Electricians and Work carried out by Journeymen and/or registered apprentices only.
 - .6 Obtain all necessary permits & pay all fees and arrange for inspection with City of Winnipeg.
 - .7 Obtain a certificate of final inspection and approval from inspection department having jurisdiction on completion of Work.
 - .8 All materials, tools, appliances, scaffolding, apparatus and labour necessary for the execution, erection and completion of specified systems shall be furnished.
 - .9 Provide all labour and materials necessary for complete and operating systems as indicated on the drawings and specified herein. Any Work and material, even if not shown or specified, which is obviously necessary or reasonably implied to complete the Work shall be provided as if it was both shown, and specified.
 - .10 Unless otherwise specifically noted, any issues which are not part of electrical / telecommunication area of expertise, even if mentioned in these documents, are indicated only for reference and coordination purposes only (with other trades).
-

- .11 The Electrical Subcontractor shall consult with all other sub-trades involved to confirm the locations of the various outlets and equipment and shall cooperate fully to ensure that no conflict arises during the installation. In case of any difference of opinion, the matter shall be referred to the Contract Administrator for final decision.
- .12 Electrical Subcontractor is responsible for arranging and coordinating with other divisions for proper drainage of electrical conducts entering from outside, drainage of all exterior electrical junction and pull boxes, sealing and waterproofing of all electrical penetrations; methods of firestopping, and envelope penetration.

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 All electrical design drawings, details and specifications are diagrammatic, and unless specifically noted by figured dimensions, indicate the general arrangement of receptacles, light fixtures, switches, risers, panels, etc. Any information involving accurate dimensions, shall be obtained from detailed dimensioned drawings or by actual measurements at the building. If doubt exists as to the final location, the Electrical Subcontractor shall contact the Contract Administrator for clarification prior to installation. The location of switches, receptacles, outlets, etc., shall be coordinated with built-in units, appliances and equipment, mechanical equipment, etc., as shown on the architectural and mechanical drawings and/or as existing.
- .2 Where space is indicated for future equipment, leave such space clear and install feeders and equipment pertaining to this contract in such a way that future equipment can be easily installed.
- .3 Electrical Subcontractor shall coordinate locations of lighting fixtures with sprinklers, mechanical ducts, diffusers, beams and other architectural, structural and mechanical items. Any relocation required shall be performed at no cost to the City
- .4 Operating voltages: to CAN3-C235.
- .5 Language operating requirements: provide identification nameplates and labels for control items in English.

1.5 PLANS

- .1 The Electrical Subcontractor shall familiarize them self with the plans which show the approximate locations of outlets and apparatus. The right is reserved to make such changes in location as may be necessary to meet contingencies of construction. No extras will be allowed for such changes to any piece of electrical equipment, outlets, etc., unless the distance exceeds 3000mm.
 - .2 Should a discrepancy appear between plans, specifications, or the actual conditions encountered on the Site, which leaves the Electrical Subcontractor in doubt as to the true intention and meaning of the plans and specifications, a ruling shall be obtained in writing from the Contract Administrator which will be final.
-

1.6 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings:
 - .1 Prior to manufacturing any item required for this job, the Electrical Subcontractor shall submit detailed shop drawings of the item. 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.
 - .2 Shop drawings must be received by the Contract Administrator at a date early enough to permit reasonable study prior to review and manufacturer, or to permit alterations where necessary. Facsimile transmission of shop drawings will **NOT BE ACCEPTED**. Late submissions of shop drawings will be sufficient reason for stoppage of construction pending review, or removal and replacement of any unsatisfactory item at the Electrical Subcontractor's expense.
 - .3 Electrical Subcontractor shall allow a minimum of ten (10) business days for shop drawing review by the Contract Administrator and time shall be incorporated in construction schedule so no delays occur due to late submission of shop drawings.
 - .4 Shop drawings shall to be submitted by email, bearing Electrical Subcontractors' signatures. All shop drawings shall be stamped by the Electrical Subcontractor prior to submission. Prints will be returned with review stamp and/or appropriate comments.
 - .5 Shop drawings shall be reviewed by the Contract Administrator. Corrections or comments made on the shop drawings during this review do not relieve Electrical Subcontractor from compliance with requirements of the drawings and specifications. This review is only for the general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Electrical Subcontractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his or her Work with that of all other trades and performing all Work in a safe and satisfactory manner.
 - .6 Shop drawings shall be provided for all system components.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Any electrical material and/or equipment supplied by Contractor or Subcontractors for installation on this project must bear evidence of certification by authorized organization (e.g. CSA) or special certification acceptable to the Chief Inspector of Electrical Energy for the Province of Manitoba.
 - .2 Any material and/or equipment not complying with this requirement and found on the job Site will be subject to rejection and replacement with approved equipment at no additional cost
 - .3 Electrical Subcontractor, upon receipt of equipment purchased by the City for installation on this project, shall examine it for compliance with the above requirements. Report any non approved equipment to the Contract Administrator for action. Such equipment shall be returned to its packing crate until instructions are received from the Contract Administrator.
 - .4 Submit test results of installed electrical and telecommunication systems.
 - .5 Permits and fees: in accordance with General Conditions of contract.
 - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Contract Administrator.

- .4 Substitutions:
 - .1 Unless otherwise noted on the plans or specifications, substitutions may be allowed by the Contract Administrator, when requested by the Electrical Subcontractor or by equipment suppliers, for items specified by manufacturer and catalogue number.
 - .2 Requests for review of such substitutions shall be submitted via email at least seven working days prior to the Bid date. Facsimile transmission of substitution drawings and/or specifications will **NOT BE ACCEPTED**.
 - .3 Descriptive catalogue sheets accompanying the approval application which may show several items of varying specifications shall be conspicuously marked in such a manner that the offered substitute item may easily be recognized for comparison.
 - .4 Proposed substitutions must be at least of equal quality to that of the specified item. The manufacturer's specification of the item shall apply for comparison if no other clause of this specification applies. The Contract Administrator will review substitution proposal and will make final decision for the City.
 - .5 Off-the-shelf items which are specified by description only, without any manufacturer, model type or catalogue number, do not require approval prior to the Bid date. However, Electrical Subcontractor shall submit to the Contract Administrator a request for review of such items prior to their use, in sufficient time to permit rejection if unsatisfactory.
 - .6 All additional expenses incurred as a result of substitution will be the direct responsibility of the Electrical Subcontractor.
- .5 O&M Manuals:
 - .1 Submit O&M manuals in a binder complete with warranty certificate, closed out permit, as-builts, and equipment specification sheets.

1.7 **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 or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Acts 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.

1.8 **DELIVERY, STORAGE AND HANDLING**

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 11 - Cleaning.

1.9 **SYSTEM STARTUP**

- .1 Instruct Operating Personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction before delivery to Site and submit such approval as described in PART 1 - SUBMITTALS.
- .2 Factory assemble control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.3 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and Contract Administrator.
- .2 Decal signs, minimum size 175 x 250 mm.

2.4 WIRING TERMINATIONS

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

2.5 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment, including but not limited to electrical Motor Starters, Motor Control Centres, Disconnect Switches, Panel Boards and control panels.
 - .1 Nameplates:
 - .1 Equipment supplied by the non-emergency power system shall be identified using lamicoid 3 mm matt black finish face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Equipment supplied by the emergency power system shall be identified using lamicoid 3 mm matt red finish face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.

.2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Contract Administrator prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate tag, capacity, primary and secondary voltages.

2.6 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered, 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.

2.7 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 5 m intervals.

2.8 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green" finish.
 - .2 Paint indoor switchgear and distribution enclosures light grey to EEMAC 2Y-1.

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 The Electrical Subcontractor shall obtain and ascertain information from all other sub-trades as to the extent and details of any additional electrical Work to complete all systems served with electrical power or controlled electrically and, where necessary, allow in his Bid for such Work. No extra claim will be accepted for Work on such systems whether they are; as specified in architectural, structural, landscape or mechanical plans and specifications; or proposed and accepted as alternate systems.
- .4 Any electrical and communication Work carried out on behalf of, or by, other Subcontractors shall be in accordance with the regulations of the Canadian Electrical Code and the applicable clauses of this specification.
- .5 It shall be the Electrical Subcontractor's responsibility to ensure that all Subcontractors and suppliers of electrical equipment observe the applicable clauses of the electrical specifications.
- .6 In case of differences between Subcontractors regarding extent of Work responsibilities, such matters shall be referred to the Contract Administrator through the Electrical Subcontractor. Should any discrepancy between the specification and drawings leave the Electrical Subcontractor in doubt as to the true intent and meaning, a ruling shall be obtained from the Contract Administrator before the Bid is submitted. If this is not done it will be the Electrical Subcontractor's responsibility to ensure that the more expensive alternate has been included.
- .7 Prior to the Bid, the Electrical Subcontractor shall visit the Site and report to the Contract Administrator any condition which might prevent him from performing his contract as specified. No extra will be allowed for if this procedure is not followed.
- .8 Should any Work or material be needed which is not specified or shown on the drawings and is nevertheless necessary for properly carrying out the obvious intent, such Work or materials shall be provided without additional cost.

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

3.4 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. Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1200 mm to top.
 - .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: 100 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.

3.5 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.6 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, Security System, PA system, 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 Contract Administrator.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

3.7 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 RELATED WORK

.1	Mechanical Specifications	Division 22 and 23
.2	Common Work Results	Section 260500
.3	Wires and Cables (0-1000 V)	Section 260521
.4	Outlet Boxes, Conduit Boxes and Fittings	Section 260532
.5	Conduits, Conduit Fastenings and Conduit Fittings	Section 260534
.6	Disconnect Switches - Fused and Non-Fused	Section 262823

1.2 SYSTEM DESCRIPTION

- .1 Provide complete electrical power and control connections for mechanical equipment.

Part 2 Products

2.1 MATERIALS

- .1 Include motor starters, lockable disconnects, conduit, wire, fittings, interlocks, outlet boxes, junction boxes, and all associated equipment required to provide power wiring for mechanical equipment, unless otherwise indicated.
- .2 Include pushbutton stations, motor protective switches, interlocks, conduit, wire, devices, and fittings required to provide control wiring for mechanical equipment, except for temperature/humidity control systems.
- .3 Unless otherwise noted, motors and control devices shall be supplied by Division 22 and 23. Motor horsepower ratings shall be as shown in the Division 22 and 23 specifications. Motor voltage and phase ratings by Division 26.

2.2 EXTERIOR EQUIPMENT

- .1 All equipment, mounted on the exterior of the building, shall be weatherproof.

Part 3 Execution

3.1 POWER WIRING

- .1 Install power feeders, starters, lockable disconnects, and associated equipment and make connections to all mechanical equipment.
- .2 Install branch circuit wiring for mechanical system control panels, time clocks, and control transformers.
- .3 Install main power feeders to starter/control panels furnished by Division 22 and 23. Install branch wiring from starter/control panels to controlled equipment such as motors, electric coils, etc.
- .4 Conduit, wire, devices and fittings required to wire and connect low voltage temperature control systems, shall be supplied and installed by the trade supplying the temperature control system. Control wiring shall be installed in conduit.
- .5 Wire and connect electrical interlocks for starters supplied by Division 22 and 23.

3.1 COORDINATION

- .1 Refer to mechanical drawings for the exact location of motor control devices, and other mechanical equipment requiring an electrical connection.
- .2 Obtain full information from Division 22 and 23, regarding wiring controls, overload heaters, equipment ratings and over-current protection. Notify the Division 22 and 23, at once, if any information provided is incorrect or unsatisfactory.
- .3 Refer to Division 22 and 23 specifications for any further electrical requirements.
- .4 Review both electrical and mechanical drawings and specifications and coordinate all controls with Mechanical Subcontractors through Electrical Subcontractor. Report all discrepancies to the Contract Administrator before close of Bid. No additional money will be justified for assumptions made on any duplication of information.
- .5 Submit to Electrical Subcontractor, as part of the bid submission, a list of controls and wiring to be provided by the Electrical Subcontractor.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for wire and box connectors.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No.18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2 No.65-93, 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)

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2 No.65, with current carrying parts of copper or copper alloy sized to fit copper or aluminum conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2 No.65, with current carrying parts of copper or copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable, aluminum sheathed cable, flexible conduit, non-metallic sheathed cable as required to: CAN/CSA-C22.2 No.18.Execution

2.2 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 C22.2 No.65.
 - .3 Install fixture type connectors and tighten. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with NEMA.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 PRODUCT DATA

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

1.3 SCOPE OF WORK

- .1 Provide a complete system of wiring system, making all required connections as indicated on the drawings, specified herein and as required. Unless noted as larger, install and rate all cables and conductors in accordance with the requirements of the current edition of the Canadian Electrical Code.
- .2 Unless otherwise noted, all systems in the building shall be wired in conduit.

Part 2 Products

2.1 WIRES

- .1 Unless otherwise shown or specified, all conductors shall be 98% conductivity copper 600 volt "RW90" X-link insulated, and be of minimum size #12 AWG.
- .2 Provide cross-linked thermosetting polyethylene (RW90 X-link) type insulation for all fire alarm system conductors. Where run in cable form with outer jacket, insulation rating on individual conductors to be 105 degrees C.
- .3 Wiring drops for luminaires to be copper, #14 AWG flame retardant, heat and moisture resistant, rated at 600 volt, 125 degrees C Insulation.
- .4 All conductors to be copper only, unless otherwise noted.
- .5 Conductors up to #10 AWG may be solid. Conductors #8 AWG and larger shall be stranded, unless specifically mentioned to be solid.
- .6 Equipment bonding conductors shall be insulated and sized as per the CEC.

2.2 CONNECTORS AND TERMINALS

- .1 Use solderless, self-insulated connectors for hand twist wire joints for lighting, small power, heating and associated control devices.
- .2 Connectors #8 AWG gauge and larger shall be compression type.
- .3 Terminals shall be compression type with spade type lugs.

Part 3 Execution

3.1 INSTALLATION

- .1 Conductor length for parallel feeders to be identical.
-

- .2 Lace or clip groups of feeder conductors at all distribution centres, pull boxes, panel boards and termination points.
- .3 All exterior wiring to be RW90 X-link with 600 volt insulation.
- .4 Provide permanent plastic name tag indicating load fed on all cable ends.
- .5 All home run wiring shall be done in concealed conduit or box as arrange for opening walls, ceiling and floors as necessary. The exceptions are:
 - .1 ACW90 cables can be used for wiring light fixtures in the accessible suspended ceilings.
- .6 Electrical Subcontractor shall ensure that all conduits and boxes are installed concealed in brickwork, blockwork, furred out walls, steel stud and wood stud walls, unless specifically permitted. Any conduit installed on surface shall be removed and reinstalled concealed at Electrical Subcontractor's expense. All costs of making good walls and finishes will be borne by Electrical Subcontractor.
- .7 Nylon or similar pulling rope only shall be used to pull conductors into metallic and/or non-metallic conduit.
- .8 Exposed wiring, where permitted, shall be installed neatly, parallel or at right angles to the building lines.
- .9 No reduction is permitted on neutral conductors.
- .10 Only 2% voltage drop is permitted. Size wires to meet these requirements.

3.2 IDENTIFICATION OF CONDUCTORS

- .1 Line voltage conductors in conduit shall be colour coded to identify service voltage. Conductor colours for 120V circuits shall be:

120 Volt

 - Phase A Red
 - Phase B Black
 - Phase C Blue
 - Neutral White
 - Ground Green

600V conductor colour to be confirmed with the Contract Administrator.
- .2 Loop conductor in a three-way and four-way switching circuit shall be:
 - Brown
- .3 Switch leg conductors of line voltage switches on lighting and any manually controlled plug receptacle circuits shall be colour coded as follows:
 - A Yellow
 - B Orange
 - C Pink

The sequence of colours shall be repeated if more than three switch legs leave a switch box.

3.3 WORKMANSHIP

- .1 Before installing wire, ensure conduit is clean and dry. If moisture present, thoroughly dry out conduit; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type.
- .2 Installation to be free of opens and grounds. Before energization, megger each feeder to ensure that insulation resistance complies with CEC requirements
- .3 Do not install any conductor smaller than #12 AWG gauge, except where specifically indicated otherwise.
- .4 Provide sizes of conductors as required by CEC or as indicated on the drawings. Voltage drop from panels to farthest device must not exceed 2% at full load. Voltage drop from the main distribution to the panel board must not exceed 2%.

3.4 Insulation Test

- .1 The insulation resistance between wires and between any wire and ground shall not be less than the CEC requirements with all circuits complete and connected. Include tests results in maintenance manual.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 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, Qualifying Permanent Connections Used in Substation Grounding.
- .2 Canadian Standards Association, (CSA International)

1.3 SCOPE OF WORK

- .1 Provide all labour and material to constitute a complete system, equipment grounding and bonding.
- .2 Ground all components of the electrical system in accordance with the requirements of the Canadian Electrical Code, local authorities and, where more stringent, manufacturers requirements.
- .3 Securely and adequately ground all components of the electrical system in accordance with the requirements of the CEC and additional requirements set up in the contract documents.
- .4 The system shall consist of, but not be limited to cables and supports and all necessary materials to provide a complete system.

Part 2 Products

2.1 EQUIPMENT

- .1 Insulated grounding conductors: green, type RW90.
- .2 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 conductors, connectors, and accessories. Where EMT is used, run ground wire in conduit.
 - .2 All locknuts, connectors and couplings shall be tight fitting and properly cinched, throughout the entire electrical distribution system for grounding and bonding purposes as required by the CEC.
-

- .3 Ground Connections:
 - .1 When making ground and bonding connections, apply a corrosion inhibitor to contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between metals used.
- .4 All joints between conductors of #6 AWG and larger shall be made with "Cadweld" process. Special permission from Contract Administrator is required where bolted pressure lugs or screw type "Hydent" connectors are installed.
- .5 All bolted ground connections must be accessible.
- .6 Install rigid PVC conduit sleeves where ground wires pass through concrete slabs.
- .7 Connect grounding conductors to motors 10 hp and above or circuits 20A or above, with a solderless terminal and a bolt tapped to motor frame or equipment housing. Connect to smaller motors or equipment by fastening terminal to a connection box. Connect junction boxes to equipment grounding system with grounding clips mounted directly on box or with machine screws. Completely remove paint, dirt, or other surface coverings at grounding conductor connection points so good metal-to-metal contact is made.
- .8 Install bonding wire in all flexible conduit connected at each end to a grounding bushing by a solderless lug, clamp, cup washer and screw. Soldered joints not permitted.
- .9 Install #4 AWG bond wire along the full length of cable trays and between separate sections of trays and bond cable tray as required.
- .10 Ground conductors not sized on drawings are to be sized in accordance with local governing electrical authority requirements. Ground conductor size is to be no smaller than requirements specified herein this article or on drawings.
- .11 Install connectors in accordance with manufacturer's instructions.
- .12 Protect exposed grounding conductors from mechanical injury.

3.2 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 the local inspection authority. A report shall be submitted to the Contract Administrator from the testing agency.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator, if provided, during tests.

END OF SECTION

Part 1 General

1.1 Not Used

Part 2 Products

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted, suspended, set in poured concrete walls and ceilings.
- .2 All hardware, supports and channels shall be hot dipped galvanized.

Part 3 Execution

3.1 INSTALLATION

- .1 Secure equipment to masonry, tile and plaster surfaces with lead shields. Use Aluminum shields or as approved by anchoring manufactures recommendations for specific surfaces.
 - .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 where above 2700mm.
 - .2 Two-hole steel straps to secure surface conduits and cables 50 mm and smaller where below 2700mm.
 - .3 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .4 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 For surface mounting of two or more conduits use channels at 2 m on centre spacing.
 - .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
 - .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
-

- .11 Luminaires Recessed in T-Bar ceilings shall be supported independent of T-Bar system via aircraft cable or "Gripple" hangers (Toggle or Y-Hook hangers) as manufactured by Cablofil and shall be firmly attached directly to the existing or new roof building structure.
- .12 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Contract Administrator.
- .14 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.

Part 2 Products

2.1 SPLITTERS

- .1 Corrosion resistant and water tight in pool areas, otherwise sprinkler proof, sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters 400 A or less.
- .4 No Splitters without approval by Contract Administrator.

2.2 JUNCTION AND PULL BOXES

- .1 Corrosion resistant and water tight in pool areas, otherwise sprinkler proof, 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.

2.3 CABINETS

- .1 Type E: Corrosion resistant and water tight in pool areas, otherwise sprinkler proof, sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2 Type T: Corrosion resistant and water tight in pool areas, otherwise sprinkler proof, sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface or flush mounting as required.

Part 3 Execution

3.1 SPLITTER INSTALLATION

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

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
 - .2 Mount cabinets with top not higher than 2 m above finished floor.
 - .3 Install terminal block as required in Type T cabinets.
 - .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.
-

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Install size 2 identification lamacoid labels indicating system name, voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.1, Canadian Electrical Code (CEC), Part 1.

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 Combination boxes with barriers where outlets for more than one system are grouped.
- .6 All electrical boxes and fittings shall be corrosion resistant and watertight in pool areas, otherwise sprinkler proof.

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.
- .2 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished tile walls.

2.3 CONDUIT BOXES

- .1 Cast FS or FD boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle. This is only allowed in mechanical spaces.

2.4 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.5 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
 - .2 Knock-out fillers to prevent entry of debris.
 - .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
 - .4 Double locknuts and insulated bushings on sheet metal boxes.
-

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 SCOPE OF WORK

- .1 Provide conduit system as indicated herein, on the drawings and as required
- .2 All home run wiring in the building shall be installed in conduit unless otherwise noted.

Part 2 Products

2.1 CONDUITS

- .1 Rigid Steel Conduit
 - .1 Galvanized with threaded joints and connections.
 - .2 Connections in dry locations: steel or malleable iron lock nuts inside and outside enclosures.
 - .3 Connectors subject to moisture: Liquid and dust tight with insulated throat.
 - .4 Fittings: steel
 - .5 Do not use process piping in lieu of CSA approved conduit.
- .2 EMT Conduit
 - .1 Hot dipped galvanized steel conduit.
 - .2 Fittings: steel or malleable iron, liquid tight, compression-type, with insulated throat or non-metallic bushings, this is typical for all exterior connections.
- .3 Flexible Conduit
 - .1 Conduit: spiral wound, interlocking flexible.
 - .2 Connectors: slip-proof insulated throat or non-metallic bushings, steel type.

Part 3 Execution

3.1 INSTALLATION

- .1 Flexible Conduit shall be used for line and low voltage circuit connections to all motors or equipment subject to vibration and shall be metal PVC coated water tight. Connectors shall be approved for flexible liquid tight conduits.
- .2 Unless otherwise noted, Electrical Metallic Tubing (EMT) shall be utilized in the building.
- .3 Conduit for telecommunication systems shall be a minimum 21mm diameter unless noted as larger.
- .4 Install all conduit and wiring concealed, except where specifically noted otherwise. Do not recess conduit in columns or concrete slabs.
- .5 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on racks.

- .6 Lay out conduit to avoid interference with other Work. Maintain a minimum clearance of 150mm from steam or hot water piping, etc.
 - .7 Slabs on grade: install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups, through slab and extend 150mm beyond concrete. When rigid steel conduit is installed in contact with earth, it shall be protected with tape or asphaltum paint. Extend taping or paint 300mm above finished grade.
 - .8 Conduit ends emerging from concrete slab, which are to remain as exposed conduit, shall be rigid galvanized steel. Provide rigid steel oversized sleeve over the exposed PVC portion of conduit.
 - .9 All wiring shall be installed in EMT raceways with water tight connectors except where installed outdoors. All raceways installed outdoors shall be hot dipped rigid galvanized steel with treaded fittings.
 - .10 All rigid PVC conduit installed under slab on grade shall include a bonding wire sized as required by Canadian Electrical Code.
 - .11 Where used, sleeves shall be c/w proper connectors and plastic bushing (this is particularly important for telecommunications cabling installation.)
 - .12 Install a separate ground wire in conduit installed underground or in concrete or masonry slab in contact with the earth.
 - .13 Watertight fittings shall be installed in areas exposed to moisture and concrete type fittings in concrete slabs.
 - .14 Where conduit is required to be bent, do not heat and do not bend in such a way as to reduce the cross-sectional area at any point.
 - .15 For all runs of conduit, do not include more than the equivalent of four 90 degree bends, including bends located immediately adjacent to an outlet box or fitting. Provide pulling elbows, pull boxes and/or junction boxes where necessary.
 - .16 Where possible, install conduits so that they are not trapped. Cap turned up conduits to prevent the entrance of any dirt or moisture during construction. If necessary, swab out conduit and thoroughly clean internally before wires and cables are pulled.
 - .17 Take extreme care in reaming ends of all conduit to ensure a smooth, interior finish that will not damage the insulation of the wires.
 - .18 Use insulated non-metallic bushings on all conduit terminators. Ensure electrical continuity in all conduit systems. All conduits shown exposed in finished areas are to be free of labels and trade marks. Install a 45kg test line in all empty conduits. Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used. Seal conduits with duct seal where conduits are run between heated and unheated areas or into freezers. Where conduits, cables, or cable trays pierce fire separations, seal openings with approved sealing compound.
-

3.2 SLEEVES AND CHASES

- .1 Sleeves shall be provided and set for conduit passing through foundations, concrete walls and floors. Sleeves shall have sufficient diameter to allow free conduit movement resulting from thermal expansion and contraction. Sleeves installed through foundation walls, beams and footings shall be installed flush with walls, partitions, floors and ceilings. All sleeves installed below grade shall be caulked with oakum and lead on both sides of the wall. Sleeves in floors where water is present shall be caulked, graphite packing and water proof sealant used.
- .2 Exact locations of conduit stub ups for connection to service equipment, signs etc., shall be checked and verified with the Contract Administrator. Shop drawings shall be issued prior to rough-in and slab being poured.
- .3 No extra claim will be accepted by the Contract Administrator for stub up adjustments as a result of the Electrical Subcontractor not following the checking procedure as described under item 2.
- .4 Adjustments of stub ups shall be carried out to the satisfaction of the Contract Administrator. Damaged surfaces shall be repaired to their original condition. Conduit extension shall comply with Canadian Electrical Code and wires are to be re-pulled.
- .5 For each telecommunication outlet (data, voice, video etc.) provide a corresponding sleeve in every wall leading to the local cable tray to facilitate installation of telecommunication cables.

3.3 EMPTY CONDUITS

- .1 All empty conduits shall be c/w pull wires.
- .2 All conduits stubbed out shall be provided with rubber grommets and end caps.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC M1-7, Motors and Generators.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data sheets for motors. Include product characteristics, performance criteria, physical size, horsepower, watt rating, limitations and finish.
- .3 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Overall dimensions of motor.
 - .2 Shaft centreline to base dimension.
 - .3 Shaft extension diameter and keyway, coupling dimensions and details.
 - .4 Fixing support dimensions.
 - .5 Dimensioned position of ventilation openings. Details of ventilation duct attachments.
 - .6 Terminal box location and size of terminals.
 - .7 Arrangement and dimensions of accessories.
 - .8 Diagram of connections.
 - .9 Starting current and relative data necessary for use in design of motor starting equipment.
 - .10 Speed/torque characteristic.
 - .11 Weight.
 - .12 Installation data.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for motors for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Data necessary for maintenance of motors.
- .3 Manufacturer's recommended list of spare parts.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Handle motors with suitable lifting equipment.
- .2 Store motors in heated, dry, weather-protected enclosure.

1.6 QUALITY ASSURANCE

- .1 Contract Administrator reserves the right to witness standard factory testing of motors 50 hp and above.

Part 2 Products

2.1 HORSEPOWER MOTOR

2.2 MATERIALS

- .1 Motors: to EEMAC M1-7.
- .2 Lead markings: to EEMAC M2-1.
- .3 Rating: As indicated.
- .4 Motor Type: As indicated.
- .5 Service Factor: 1.15.

2.3 DESIGN LETTERS

- .1 Polyphase squirrel cage induction motors design As Indicated.

2.4 ENCLOSURE

- .1 Totally enclosed fan cooled.
- .2 Totally enclosed explosion proof for use in: Class as Indicated.

2.5 INSULATION

- .1 Class: B or as Indicated.
- .2 Ambient temperature: 40 °C or as indicated.

2.6 BEARINGS

- .1 Antifriction type bearings, fitted with readily accessible facilities for lubrication while motor running or stationary.

2.7 STARTING METHOD

- .1 All motors shall be Inverter Duty rated.
- .2 Include anchor devices and setting templates.

Part 3 Execution

3.1 INSTALLATION

- .1 Dry out motor if dampness present in accordance with manufacturer's instructions.
- .2 Install wiring, flexible connections and grounding.
- .3 Make wiring connections. Use liquid tight PVC jacketed flexible conduit between rigid conduit and motor.
- .4 Make flexible conduit long enough to permit movement of motor over entire length of slide rails.
- .5 Check for correct direction of rotation with motor uncoupled from driven equipment.
- .6 Align and couple motor to driven machinery to manufacturer's instructions, using only correct parts such as couplings, belts, sheaves, as provided by manufacturer.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data sheets for compartments. Include product characteristics, physical size and finish.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.
- .4 Submit shop drawings and indicate:
 - .1 Outline dimensions.
 - .2 Configuration of identified compartments.
 - .3 Schematic and wiring diagrams.
- .5 Closeout Submittals: provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .1 Include data for each type and style of starter.

1.2 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 GENERAL DESCRIPTION

- .1 Floor mounting, free standing, enclosed dead front.

2.2 MOTOR STARTERS AND DEVICES

- .1 Provide new MCP, contactors, overloads, control transformers, relays, start/stop, reset, run light (green LED pilot light) and hand-off-auto selector switches.

2.3 STARTER UNIT COMPARTMENTS

- .1 Provide new starter unit compartments as indicated on the drawing to suit the existing MCC.
- .2 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for padlocks to lock operating handle in "off" position and lock door closed.
- .3 Hinge unit doors on same side.

2.4 WIRING IDENTIFICATION

- .1 Match existing.
-

2.5 EQUIPMENT IDENTIFICATION

- .1 Match existing.

2.6 FINISHES

- .1 Match existing.

Part 3 Execution

3.1 INSTALLATION

- .1 Install new starter unit compartments in the existing MCC as indicated on the electrical drawings.
- .2 Make field power and control connections as required.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 hours period.

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 26 05 00 - Common Work Results - Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA-C22.2 No.55-M1986, Special Use Switches.
 - .4 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20).

1.4 SHOP DRAWINGS AND PRODUCT DATA

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

Part 2 Products

2.1 SWITCHES

- .1 15 or 20 A, 120 V, single pole, three-way, or four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.
 - .2 Manually-operated general purpose ac switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle.
 - .6 Framed 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: Industrial Grade.
-

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R 5-20R and 6-50R, 125/250V V, 15/20/50 A, U ground, to: CSA-C22.2 No.42 with following features:
 - .1 White urea moulded housing for normal switches. Co-ordinate with Contract Administrator for all unique coloured receptacles.
 - .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 riveted grounding contacts.
 - .6 Nylon face
- .2 Other receptacles with ampacity and voltage as indicated.
- .3 Receptacles of one manufacturer throughout project.
- .4 Acceptable materials: Industrial Grade.

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 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 in pool areas.

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 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, and ground-fault circuit-interrupters.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489 and the 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 ampacity of 100 A and over or with interrupting capacity of 25 kA symmetrical (rms) and over at system voltage.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers and ground-fault circuit-interrupters: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation.
- .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.

2.2 THERMAL MAGNETIC BREAKERS

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 SOLID STATE TRIP BREAKERS [DESIGN D]

- .1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time and instantaneous tripping for phase and ground fault short circuit protection.

2.4 **OPTIONAL FEATURES**

- .1 Include:
 - .1 Shunt trip.
 - .2 Auxiliary switch.
 - .3 On-off locking device.
 - .4 Handle mechanism.

2.5 **ENCLOSURE**

- .1 Sprinkler proof.

Part 3 **Execution**

3.1 **INSTALLATION**

- .1 Install circuit breakers as indicated on drawings.

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 26 05 00 - Common Work Results - Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-M89, Enclosed Switches.
 - .2 CSA C22.2 No.39-M89, Fuseholder Assemblies.

1.4 SUBMITTALS

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

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Heavy-duty, non-fusible, horsepower rated disconnect switch in CSA NEMA 4X enclosure, to CAN/CSA C22.2 No.4 sized as per drawings.
- .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.
- .6 Where required (For VFDs) provide an auxiliary contact to break prior to main contacts and interlock with the VFD emergency stop.

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.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for industrial control devices including pushbutton stations, control and relay panels.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 26 05 00 - Common Work Results - Electrical.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.14-95, Industrial Control Equipment.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 1, Industrial Control and Systems: General Requirements.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include schematic, wiring, interconnection diagrams.

1.5 QUALITY ASSURANCE

- .1 Submit to Contract Administrator one copy of test results.

Part 2 Products

2.1 AC CONTROL RELAYS

- .1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.
- .2 Convertible contact type: contacts field convertible from NO to NC, electrically held solid state. Contact rating: as required.

2.2 RELAY ACCESSORIES

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

2.3 OPERATOR CONTROL STATIONS

- .1 Enclosure: CSA Type 4X, flush mounting:

2.4 PUSHBUTTONS

- .1 Illuminated, heavy duty oil tight, flush operator with 1-NO and 1-NC contacts rated at as required.

2.5 EMERGENCY STOP PUSHBUTTONS

- .1 Illuminated, heavy duty oil tight, flush operator with 1-NO and 1-NC contacts rated at as required, operator and contact block included.
-

- .2 Jumbo Red Operator.
- .3 Push to operate, key only to reset.
- .4 Lamicaid, large white letters on red background; stating "Equipment Emergency Stop".

2.6 SELECTOR SWITCHES

- .1 Maintained 3 position labelled as indicated heavy duty oil tight, operators standard, contact arrangement.

2.7 INDICATING LIGHTS

- .1 Heavy duty Oil tight, full voltage, LED type.

2.8 CONTROL AND RELAY PANELS

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

2.9 CONTROL CIRCUIT TRANSFORMERS

- .1 Single phase, dry type.
- .2 Primary: 208 V, 60 Hz ac.
- .3 Secondary: 24 or 120 VAC as required.
- .4 Rating: 100 VA minimum.
- .5 Secondary fuse: rated as required.
- .6 Close voltage regulation as required by magnet coils and solenoid valves.

Part 3 Execution

3.1 INSTALLATION

- .1 Install as required.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

1.2 SCOPE OF WORK

- .1 Supply and install starters, motors and disconnects as indicated on drawings, stated herein and as required.
- .2 Electrical Subcontractor shall wire and connect all motors, starters, disconnects, controls and appliances that form a part of the buildings heating, ventilation, and/or air conditioning systems and other such items which form a part of the construction documents including; door operators, elevators, City supplied equipment, etc. Prior to bid confirm and co-ordinate with other divisions exact requirements.
- .3 Additional control information and wiring diagrams may be available at a later date when the exact type of equipment being supplied is established. Supply and install wiring and equipment in accordance with wiring diagrams.
- .4 The Electrical Subcontractor shall co-ordinate with trades and ensure that all motor and controls which form a part of, or function with, the particular apparatus, or motorized equipment, are installed in conjunction with mechanical plans and specifications.
- .5 Prior to bids closing the Electrical Subcontractor must coordinate with trades and ensure that all motor wiring and control thereof is allowed for in Electrical bid.

1.3 DIVISION OF RESPONSIBILITY

- .1 Electrical Subcontractor shall supply and install the line voltage service to all equipment provided by Division 21, 22 and 23. Low voltage control wiring is generally included in Division 21, 22 and 23. See Mechanical Specification for reference.

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.

1.5 EXTRA MATERIALS

- .1 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.

- .3 1 contacts, auxiliary.
- .4 1 control transformer.
- .5 1 operating coil.
- .6 2 fuses.
- .7 10% indicating lamp bulbs used.

Part 2 Products

2.1 ENCLOSURES

- .1 All products shall be complete with CSA type enclosures suitable for installation location. Unless otherwise noted, or required, CSA Type 4X shall be used as a minimum standard required.

2.2 STARTERS

- .1 Three-phase motors shall be controlled with combination magnetic starters except where specifically noted on the plans or otherwise specified.
- .2 Single phase manual motor protection switches to be either toggle and/or key operated complete with pilot light. Flush and/or surface mounted as indicated, key operated where indicated.
- .3 Single phase motors running at not more than 120 volts shall be controlled and protected with manual motor starting switches overload and over-current protection except where otherwise specified.
- .4 Magnetic starting switches shall be of EEMAC sizes to suit the horsepower rating of the motor which they control and protect. Contactors shall be of sizes as specified. Half size starters will not be allowed.
- .5 Each magnetic motor starter shall incorporate the following facilities:
 - .1 Contactor with three overload relays.
 - .2 120 volt holding coil with under voltage protection.
 - .3 Pilot light and cover, red LED type.
 - .4 Reset button, HOA switch in cover, field convertible to off/auto or start/stop push-button as indicated.
 - .5 Two sets of normally open auxiliary contacts in addition to the standard auxiliary contacts supplied with each starter. One set of auxiliary contacts, convertible to normally closed.
 - .6 Control transformer 600 or 208/120 Volt of sufficient VA to handle operating coil and associated controls (100VA minimum).

2.3 OVERLOADS

- .1 Overloads to be coordinated with the name plate rating of the motor. Failure to do so renders the Electrical Subcontractor liable for any damage that may occur to the motors.

2.4 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with primary / secondary fusing, installed in the starter compartment.
- .2 Size control transformer for control circuit load plus 20% spare capacity (100VA minimum).

2.5 MANUFACTURERS

- .1 Pre-approved Manufacturers: Eaton Cutler Hammer, Square D and Siemens.

2.6 FINISHES

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

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 3 engraved as indicated.

Part 3 Execution

3.1 CONNECTIONS

- .1 Use flexible hanging feeder loop for connection to motors.

3.2 CO-ORDINATION

- .1 Consult with Mechanical Subcontractor for actual locations of units, starters, controls, etc., and provide all connections and devices as required.

3.3 INSTALLATION

- .1 Confirm final connections, load and locations of all motors prior to installation.
- .2 Motors for mechanical equipment to be installed under Division 21, 22 and 23. Locations of motors conduit and connection points indicated for equipment supplied are for estimating purposes only. Refer to shop drawings of the actual equipment for exact connection points, feeder size and over-current protection.
- .3 Provide line voltage power supply connections for all mechanical equipment motors.
- .4 Label and identify all junction boxes, controls, wiring, etc., as per Section 26 05 00.
- .5 Select overloads to suit full load current of motors installed. Refer to shop drawings and/or actual nameplate data for full load current of each motor.
- .6 Magnetic motor starters shall be installed where indicated on the drawings.

- .7 Select over current device trip setting for magnetic starters and combination starters to suit motors installed.
- .8 Conduit, wire and connections for control L.V. wiring for mechanical equipment motors generally is unless otherwise specified the responsibility of Division 21, 22 and 23.

3.4 FIELD QUALITY CONTROL

- .1 Operate switches, contactors to verify correct functioning.
- .2 Perform starting and stopping sequences of contactors and relays.
- .3 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION