PROJECT TITLE

Health Canada
Laboratory Upgrades
PWGSC PROJECT: R.054345.001

PROJECT NUMBER

Number R.054345.001

PROJECT DATE

2015-05-29

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Mechanical Engineering

PART 1 - GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises renovation of Rooms 115, 164, 165, 225, and clean rooms on Level 3 located at 2501 Midland Acenue, Toronto.

1.2 CONTRACT METHOD

.1 Construct Work under stipulated price contract.

1.3 WORK SEQUENCE

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

.2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.

.3 Required stages:
.1 Phase 1 - Rooms 115, 164, and clean rooms on Level 3.
.2 Phase 2 - Room 165.
.3 Phase 3 - Room 225
.4 Each phase shall be completed, commissioned and fully operational, prior to start of the next phase.

.4 Maintain fire access/control.

1.4 CONTRACTOR USE OF PREMISES

.1 Limit use of premises for Work,and for access, to allow:
.1 Owner occupancy.
.2 Partial owner occupancy.
.3 Public usage.

.2 Co-ordinate use of premises under direction of Consultant.

.3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

.4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.

.5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Consultant.

.6 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

1.5 OWNER OCCUPANCY

.1 Owner will occupy premises during entire construction period for execution of normal operations.

.2 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.8 OWNER FURNISHED ITEMS

.1 Owner Responsibilities:
.1 Arrange for delivery of shop drawings, product data, samples, manufacturer's instructions, and certificates to Contractor.
.2 Deliver supplier's bill of materials to Contractor.
.6 Arrange for replacement of damaged, defective or missing items.

.2 Contractor Responsibilities:
.1 Designate submittals and delivery date for each product in progress schedule.
.2 Review shop drawings, product data, samples, and other submittals. Submit to Consultant notification of observed discrepancies or problems anticipated due to non-conformance with Contract Documents.
.3 Receive and unload products at site.
.4 Inspect deliveries jointly with Owner; record shortages, and damaged or defective items.
.5 Handle products at site, including uncrating and storage.
.6 Protect products from damage, and from exposure to elements.
.7 Assemble, install, connect, adjust, and finish products.
.8 Provide installation inspections required by public authorities.
.9 Repair or replace items damaged by Contractor or subcontractor on site (under his control).

1.9 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

.1 Execute work with least possible interference or disturbance to building operations and occupants, public and normal use of premises.

.2 Use only elevators, existing in building for moving workers and material.

.1 Protect walls of passenger elevators, to approval of Consultant prior to use.
.2 Accept liability for damage, safety of equipment and overloading of existing equipment.

1.10 EXISTING SERVICES

.1 Notify, Consultant and utility companies of intended interruption of services and obtain required permission.

.2 Where Work involves breaking into or connecting to existing services, give 48 owner ours noticoe for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to tenant operations.

.3 Provide alternative routes for pedestrian and vehicular traffic.

.4 Establish location and extent of service lines in area of work before starting Work. Notify Consultant of findings.

.5 Submit schedule to and obtain approval from Consultant for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.

.6 Provide temporary services when directed by Consultant to maintain critical building and tenant systems.

.7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.

.8 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.

.9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.

.10 Record locations of maintained, re-routed and abandoned service lines.

1.11 DOCUMENTS REQUIRED

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

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 ACCESS AND EGRESS

.1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.2 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.

.2 Maintain existing services to building and provide for personnel and vehicle access.

.3 Where security is reduced by work provide temporary means to maintain security.

.4 Departmental Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.

.5 Use only elevators existing in building for moving workers and material.
.1 Protect walls of passenger elevators, to approval of Departmental prior to use.
.2 Accept liability for damage, safety of equipment and overloading of existing equipment.

.6 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.4 EXISTING SERVICES

.1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission.

.2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.

.3 Provide for personnel and vehicular traffic.

.4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.5 SPECIAL REQUIREMENTS

.1 Carry out noise generating Work Monday to Friday from 18:00 to 07:00 hours and on Saturdays and Sundays.

.2 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.

.3 Keep within limits of work and avenues of ingress and egress.

.4 Deliver materials outside of peak traffic hours 17:00 to 07:00 and 13:00 to 15:00 unless otherwise approved by Departmental Representative.

1.6 SECURITY

.1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.

.2 Security clearances:
.1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises.
.2 Obtain requisite clearance, as instructed, for each individual required to enter premises.
.3 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.

.3 Security escort:

.1 Personnel employed on this project must be escorted when executing work in non-public areas during normal working hours. Personnel must be escorted in all areas after normal working hours.
.2 Submit an escort request to Departmental Representative at least 14 days before service is needed. For requests submitted within time noted above, costs of security escort will be paid for by Departmental Representative. Cost incurred by late request will be Contractor's responsibility.
.3 Any escort request may be cancelled free of charge if notification of cancellation is given at least 4 hours before scheduled time of escort. Cost incurred by late request will be Contractor's responsibility.
.4 Calculation of costs will be based on average hourly rate of security officer for minimum of 8 hours per day for late service request and of 4 hours for late cancellations.

1.7 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions. Smoking is not permitted.

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 SECTION INCLUDES

.1 Cash allowances.

1.2 CASH ALLOWANCES

.1 Include in Contract Amount, cash allowances stated herein.

.2 Cash allowances, unless otherwise specified, cover net cost to Contractor of services, products, construction machinery and equipment, freight, handling, unloading, storage installation and other authorized expenses incurred in performing Work.

.3 Contract Amount, and not cash allowance, includes Contractor's overhead and profit in connection with such cash allowance.

.4 Contract Amount will be adjusted by written order to provide for an excess or deficit to each cash allowance.

.5 Where costs under a cash allowance exceed amount of allowance, Contractor will be compensated for any excess incurred and substantiated plus an allowance for overhead and profit as set out in Contract Documents.

.6 Progress payments on accounts of work authorized under cash allowances shall be included in Departmental Representative's monthly certificate for payment.

.7 Schedule shall be prepared jointly by Departmental Representative and Contractor to show when items called for under cash allowances must be authorized by Departmental Representative for ordering purposes so that progress of Work will not be delayed.

.8 Amount of each allowance, for Work specified in respective specification Sections is as follows:

.1 Include an allowance of $10,000 for disconnection and reconnection of security card readers as required by owner.

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 Departmental Representative 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.

.5 Review submittals prior to submission to Departmental Representative. 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.

.6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work are co-ordinated.

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

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.

.10 Keep one reviewed copy of each submission on site.

.11 Submit number of hard copies specified for each type and format of submittal and also submit in electronic format as pdf files. Forward pdf files on CD or through email.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other d which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario of Canada.

.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Allow 7 working days for Departmental Representative's review of each submission.

.5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Amount. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.

.7 Accompany submissions with transmittal letter, in duplicate, containing:
.1 Date.
.2 Project title and number.
.3 Contractor's name and address.
.4 Identification and quantity of each shop drawing, product data and sample.
.5 Other pertinent data.

.8 Submissions shall include:
.1 Date and revision dates.
.2 Project title and number.

.3 Name and address of:
.1 Subcontractor.
.2 Supplier.
.3 Manufacturer.
.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
.5 Details of appropriate portions of Work as applicable:
.1 Fabrication.
.2 Layout, showing dimensions, including identified field dimensions, and clearances.
.3 Setting or erection details.
.4 Capacities.
.5 Performance characteristics.
.6 Standards.
.7 Operating weight.
.8 Wiring diagrams.
.9 Single line and schematic diagrams.
.10 Relationship to adjacent work.

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

.10 Submit three hard copies and one electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

.11 Submit three hard copies and one electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.

.12 Submit three hard copies and one electronic copy of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
.2 Testing must have been within 3 years of date of contract award for project.

.13 Submit three hard copies and one electronic copy of certificates for requirements requested in specification Sections and as requested by Departmental Representative.

.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.

.14 Submit three hard copies and one electronic copy of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.15 Submit three hard copies and one electronic copy of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.

.16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.17 Submit three hard copies and one electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.

.18 Delete information not applicable to project.

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

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

.21 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

.1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to Departmental Representative's business address.

.3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

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

.5 Adjustments made on samples by Departmental Representative are not intended to change Contract Amount. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 PHOTOGRAPHIC DOCUMENTATION

.1 Submit electronic copy of colour digital photography in jpg format, fine resolution monthly with progress statement and as directed by Departmental Representative.

.2 Project identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 4 locations.
.1 Viewpoints and their location as determined by Departmental Representative.

.4 Frequency of photographic documentation: weekly monthly as directed by Departmental Representative.
.1 Upon completion of: framing and services before concealment, of Work, and as directed by Departmental Representative.

1.5 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Safety and Insurance Board Experience Report.

.2 Submit transcription of insurance immediately after award of Contract.

1.6 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.

.4 Submit acceptable certificate stating that suspended ceiling systems provide adequate support for electrical fixtures, as required by current bulletin of Electrical Inspection Department of Ontario Hydro.

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 Canadian Standards Association (CSA): Canada
.1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.

.2 National Building Code 2010 (NBC):
.1 NBC 2010, Division B, Part 8 Safety Measures at Construction and Demolition Sites.

.3 National Fire Code 2010 (NFC):
.1 NFC 2010, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.

.4 Province of Ontario:
.1 Occupational Health and Safety Act Revised Statutes of Ontario 1990, Chapter O.1 as amended, and Regulations for Construction Projects, O. Reg. 213/91 as amended.
.2 O. Reg. 490/09, Designated Substances.
.3 Workplace Safety and Insurance Act, 1997.
.4 Municipal statutes and authorities.

.5 Treasury Board of Canada Secretariat (TBS):
.1 Treasury Board, Fire Protection Standard April 1, 2010
www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=17316&section=text.

.6 Fire Commissioner of Canada (FCC):
.1 FC-301 Standard for Construction Operations, June 1982.
.2 FC-302 Standard for Welding and Cutting, June 1982.

Labour Program
Fire Protection Engineering Services
4900 Yonge Street 8th Floor
North York, Ontario M2N 6A8

and copies may be obtained from:

Human Resources and Social Development Canada
Labour Program
Fire Protection Engineering Services
Ottawa, Ontario K1A 0J2

1.2 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00.

.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 operations found in work plan.
.3 Measures and controls to be implemented to address identified safety hazards and risks.
.4 Provide a Fire Safety Plan, specific to the work location, in accordance with NBC, Division B, Article 8.1.1.3 prior to commencement of work. The plan shall be coordinated with, and integrated into, the existing Building, and Evacuation Plan in place at the site. Departmental Representative will provide Building, Facility, Tenant's Emergency Procedures and Evacuation Plan. Deliver two copies of the Fire Safety Plan to the Departmental Representative not later than 14 days before commencing work.
.5 Contractor's and Sub-contractors' Safety Communication Plan.
.6 Contingency and Emergency Response Plan addressing standard operating procedures specific to the project site to be implemented during emergency situations. Coordinate plan with existing Building, Facility, Tenant's Emergency Response requirements and procedures provided by Departmental Representative.

.3 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

.4 Submit names of personnel and alternates responsible for site safety and health.

.5 Submit records of Contractor's Health and Safety meetings when requested.

.6 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.

.7 Submit copies of incident and accident reports.

.8 Submit Material Safety Data Sheets (MSDS).

.9 Submit Workplace Safety and Insurance Board (WSIB)- Experience Rating Report.

1.3 PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:
.1 Asbestos
.2 Lead
.3 Silica
.4 Mercury

.2 Refer to Designated Substances and Hazardous Materials Survey and Report

1.4 FILING OF NOTICE

.1 File Notice of Project with Provincial authorities prior to commencement of Work.

1.5 WORK PERMIT

.1 Obtain building permits related to project prior to commencement of Work.

.2 Obtain "Permit to Work" and "Hot work Permit" from SNC-Lavalin

1.6 SAFETY ASSESSMENT

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

1.7 MEETINGS

.1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.

1.8 REGULATORY REQUIREMENTS

.1 Comply with the Acts and regulations of the Province of Ontario.

.2 Comply with specified standards and regulations to ensure safe operations at site.

1.9 GENERAL REQUIREMENTS

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

.2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements.

.3 Relief from or substitution for any portion or provision of minimum Health and Safety standards specified herein or reviewed site-specific Health and Safety Plan shall be submitted to Departmental Representative in writing.

1.10 COMPLIANCE REQUIREMENTS

.1 Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990 Chapter 0.1, as amended.

1.11 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.

.3 Where applicable the Contractor shall be designated "Constructor", as defined by Occupational Health and Safety Act for the Province of Ontario.

1.12 UNFORSEEN HAZARDS

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

.2 Follow procedures in place for Employees Right to Refuse Work as specified in the Occupational Health and Safety Act for the Province of Ontario.

1.13 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 site-related working experience specific to activities associated with abatement of lead and asbestos containing materials.

.2 Have working knowledge of occupational safety and health regulations.

.3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

.4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

1.14 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 of Ontario, and in consultation with Departmental Representative.

.1 Contractor's Safety Policy.

.2 Constructor's Name.

.3 Notice of Project.

.4 Name, trade, and employer of Health and Safety Representative or Joint Health and Safety Committee members (if applicable).

.5 Ministry of Labour Orders and reports.

.6 Occupational Health and Safety Act and Regulations for Construction Projects for Province of Ontario.

.7 Address and phone number of nearest Ministry of Labour office.

.8 Material Safety Data Sheets.

.9 Written Emeregency Response Plan.

.10 Site Specific Safety Plan.

.11 Valid certificate of first aider on duty.

.12 WSIB "In Case of Injury At Work" poster.

.13 Location of toilet and cleanup facilities.

1.15 CORRECTION OF NON-COMPLIANCE

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

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

.3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.16 WORK STOPPAGE

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

.2 Assign responsibility and obligation toHealth and Safety Coordinator to stop or start Work when, at Health and Safety Coordinator's discretion, it is necessary or advisable for reasons of health or safety. Departmental Representative may also stop Work for health and safety considerations.

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 DEFINITIONS

.1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade environment aesthetically, culturally and/or historically.

.2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00.

.2 Prior to commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative. Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.

.3 Address topics at level of detail commensurate with environmental issue and required construction tasks.

.4 Environmental protection plan: include:
.1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
.2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
.3 Names and qualifications of persons responsible for training site personnel.
.4 Descriptions of environmental protection personnel training program.

.5 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for marking limits of use areas including methods for protection of features to be preserved within authorized work areas.
.6 Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
.7 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.
.8 Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.

1.3 FIRES

.1 Fires and burning of rubbish on site is not permitted.

1.4 DISPOSAL OF WASTES

.1 Do not bury rubbish and waste materials on site.

.2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

1.5 POLLUTION CONTROL

.1 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

.2 Spills of deleterious substances:
.1 Immediately contain, limit spread and clean up in accordance with provincial regulatory requirements.
.2 Report immediately to Ontario Spills Action Centre: 1-800-268-6060.

1.7 NOTIFICATION

.1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.

.2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.

.3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.

.4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

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 AND CODES

.1 Perform Work in accordance with National Building Code of Canada (NBC) 2010, National Fire Code of Canada (NFC) 2010 and Ontario Building Code (OBC) 2006, including all amendments up to bid closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.

.2 Meet or exceed requirements of:
.1 Contract documents.
.2 Specified standards, codes and referenced documents.

1.2 HAZARDOUS MATERIAL DISCOVERY

.1 Stop work immediately and notify Departmental Representative if materials which may contain designated substances or PCB's are discovered in course of work.

1.3 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions.

1.4 IAQ - INDOOR AIR QUALITY

.1 Comply with CSA-Z204-94(R1999), Guideline for Managing Indoor Air Quality in Office Buildings.

1.5 ACCESSIBLE DESIGN

.1 Comply with CAN/CSA-B651-04(R2010), Accessible Design for the Built Environment, unless specified otherwise. In any case of conflict or discrepancy between the building codes and CAN/CSA-B651, the requirements of CAN/CSA-B651 shall apply.

1.6 STATISTICAL INFORMATION

.1 Provide statistical information to Departmental Representative:
.1 Within ten working days after March 31 and September 30 occurring between commencement of work and final completion
.2 Within ten working days after final completion.

.2 Include in statistical information:

.1 Statement of total person days of labour used on site in performance of contract, including labour provided under sub-contracts.
.2 Estimate of total value in dollars of material delivered to site and installed, including material provided and installed under sub-contracts.

.3 This information is required by Government of Canada solely to provide statistics that will aid in assessing socio-economic benefits of this project.

1.7 TAXES .1 Pay applicable Federal, Provincial and Municipal taxes.

1.8 EXAMINATION .1 Examine existing conditions and determine conditions affecting 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 ABBREVIATIONS AND ACRONYMS

.1 The abbreviations and acronyms are commonly found in the Project Manual and represent the associated organizations or terms.

1.2 MATERIALS, EQUIPMENT AND METHODS

.1 A:
- .1 AC: acoustic.
- .2 AC PAN: acoustic panel.
- .3 ACU: acoustic unit ceiling.
- .4 AFF: above finished floor.
- .5 AC PLAS: acoustic plaster.
- .6 ACT: acoustic tile.
- .7 ACR CU LVR: acrylic cube louvre.
- .8 ADH: adhesive.
- .9 ADJ: adjustable.
- .10 A/C: air conditioner.
- .11 AL: aluminum.
- .12 AB: anchor bolt.
- .13 ANOD: anodized.
- .14 ARCH: architecture.
- .15 ARCH BLK: architectural block.
- .16 AVB: air vapour barrier.

.2 B:
- .1 B: base.
- .2 BEAST: benthic assessment of sediment.
- .3 BH: bore hole.
- .4 BL: bottom layer.
- .5 BLK: block.
- .6 BLKD: bulkhead.
- .7 BM: beam.
- .8 BOT: bottom.
- .9 BMP: best management practice.
- .10 B PL: base plate.
- .11 BRG: bearing.
- .12 BRK: brick.
- .13 BSMT: basement.
- .14 BTEX: benzene, toluene, ethylbenzene and xylenes.
- .15 BUR: built-up roof.

.3 C:
- .1 CAL: caliper.
- .2 CANTIL: cantilever.
- .3 CB: catch basin.
- .4 CC: centre to centre.
- .5 CCN: contemplated change notice.
- .6 CDF: controlled density fill.
- .7 CEC: Canadian Electical Code.
- .8 CF: chair fabric.
- .9 CHAN: channel.
- .10 CHS: Canadian hydrographic service.

.11 CJ: construction joint.
.12 CL: centreline.
.13 CK: cork.
.14 CLG: ceiling.
.15 CLR: clear.
.16 COL: column.
.17 CONC: concrete.
.18 CONC BLK: concrete block.
.19 CONC BRK: concrete brick.
.20 CONT: continuous.
.21 CONT J: control joint.
.22 COMPL: complete.
.23 CM: centimetre. (Nursery stock).
.24 CPL: cement plaster.
.25 CPM: critical path method.
.26 CPT: carpet.
.27 CPTT: carpet tile.
.28 CT: ceramic tile.
.29 CVT: conductive vinyl tile.
.30 C/W: complete with.

.4 D:
.1 D: deep.
.2 DD: dutch door.
.3 DEG: degree.
.4 DF: drinking fountain.
.5 DIA: diameter.
.6 DIM: dimension.
.7 DL: dead load.
.8 DMNT: demountable.
.9 DP: dampproofing.
.10 DR: door.
.11 DRP: drapery.
.12 DWL: dowel.

.5 E:
.1 EA: each.
.2 EC: epoxy coating.
.3 ECF: engineered containment facility.
.4 EE: each end.
.5 EF: each face.
.6 EL: elevation.
.7 ELEC: electric.
.8 ELEV: elevator.
.9 EM: expanded metal.
.10 ENCL: enclosure.
.11 EQ: equal.
.12 EXH: exhaust.
.13 EXIST: existing.
.14 EXPJ: expansion joint.
.15 EXP STRUCT: exposed structure.
.16 EXT: exterior.
.17 EW: each way.

.6 F:
.1 FC: fuel contributed.
.2 FD: floor drain.

.3 FDN: foundation.
.4 FEAT W: feature wall.
.5 FEXT: fire extinguisher.
.6 FH: fire hose.
.7 FHC: fire hose cabinet.
.8 FHR: fire hose rack.
.9 FIN: finish.
.10 FIP: federal identity program.
.11 FL: floor.
.12 FLD: field.
.13 FLUOR: fluorescent.
.14 FR: frame.
.15 FRR: fire resistance rating.
.16 FTG: footing.

.7 G:
.1 GALV: galvanized steel.
.2 GB: grab bar.
.3 GBD: gypsum board.
.4 GC: General Conditions.
.5 GF: ground floor.
.6 GFCI: ground fault circuit interrupter.
.7 GL: glass or glazing.
.8 GL BLK: glass block.
.9 GPC: gypsum plaster ceiling.
.10 GPW: gypsum plaster wall.
.11 GT: glass tile.

.8 H:
.1 HB: hose bib.
.2 HC: hollow core.
.3 HCWD: hollow core wood door.
.4 HD: hand dryer.
.5 HDW: hardware.
.6 HDWD: hardwood.
.7 HM: hollow metal.
.8 HOR: horizontal.
.9 HOR EF: horizontal each face.
.10 HP: hydro pole.
.11 HPA: Hamilton Port Authority.
.12 HR: hour.
.13 HRV: heat recovery ventilator.
.14 HT: height.
.15 HTR: heater.
.16 HWT: hot water tank.
.17 HYD: hydrant.

.9 I:
.1 ICF: insulated concrete formwork.
.2 ID: inside diameter.
.3 INS: insulation.
.4 INTLK: interlock.

.10 J:
.1 JT: joint.

.11 K:

.1 KPL: kick plate.

.12 L:
.1 LAV: lavatory.
.2 LDG: landing.
.3 LG: long.
.4 LINO: linoleum.
.5 LL: live load.
.6 LT: light.

.13 M:
.1 MAS: masonry.
.2 MAS FL: masonry flashing.
.3 MAX: maximum.
.4 MBG: metal bar grating.
.5 MCL: metal cube louvre.
.6 MECH: mechanical.
.7 MET: metal.
.8 MET DK: metal deck.
.9 MET FL: metal flashing.
.10 MET GRID CLG: metal grid ceiling.
.11 MET GRTG: metal grating.
.12 MET LIN CLG: metal linear ceiling.
.13 MET T PTN: metal toilet partition.
.14 MH: maintenance hole.
.15 MIN: minimum.
.16 MLP: metal lath and plaster.
.17 MO: masonry opening.
.18 MR: marble.
.19 MT: metal threshold.
.20 MWP: membrane waterproofing.

.14 N:
.1 NBC: national building code.
.2 NF: near face.
.3 NFC: national fire code.
.4 NIC: not in contract.
.5 NO: number.
.6 NRC: noise reduction coefficient.
.7 NRP: non removable pin.
.8 NTS: not to scale.

.15 O:
.1 OBC: Ontario building code.
.2 OC: on centre.
.3 OD: outside diameter.
.4 OPNG: opening.
.5 OPR: operator.
.6 OVHD: overhead.
.7 OWSJ: open web steel joist.

.16 P:
.1 P: prefinished.
.2 PAH: polynuclear aromatic hydrocarbons.
.3 PARG: parging.
.4 PCC: precast concrete.
.5 PCT: porcelain ceramic tile.

.6 PED ACS FLG: pedestal access flooring.
.7 PF: panel fabric.
.8 PL: plate.
.9 PLAM: plastic laminate.
.10 PLAS: plaster.
.11 PLYWD: plywood.
.12 PR: pair.
.13 PREFAB: prefabricated.
.14 PREFIN: prefinished.
.15 PRFL: profile.
.16 PT: paint.
.17 PTD: paper towel dispenser.
.18 PTN: partition.
.19 PVC: polyvinyl cholide.

.17 Q:
.1 QTB: quarry tile base.
.2 QTF: quarry tile floor.
.3 QTR: quarry tile roof.

.18 R:
.1 R: radius.
.2 RA: return air.
.3 RB: resilient base.
.4 RC: reinforced concrete.
.5 RCPT: receptacle.
.6 RD: roof drain.
.7 REINF: reinforced/reinforcing.
.8 REQD: required.
.9 REQT: requirement.
.10 RFT: rubber floor tile.
.11 RM: room.
.12 RO: rough opening.
.13 RP: radiant panel.
.14 RRS: recycled rubber sheet.
.15 RRT: recycled rubber tile.
.16 RSD: rolling steel door.
.17 RSF: rubber sheet flooring.
.18 RTU: roof top unit.
.19 RWL: rain water leader.

.19 S:
.1 SAN SEW: sanitary sewer.
.2 SCHED: schedule.
.3 SC: solic core.
.4 SCRN: screen.
.5 SCWD: solid core wood door.
.6 SD: smoke developed.
.7 SDT: static dissipative tile.
.8 SECT: section.
.9 SH: sill height.
.10 SIM: similar.
.11 SL: sliding.
.12 SLR: sealer.
.13 SPEC: specification.
.14 SS: stainless steel.
.15 STD: standard.

.16 STL: steel.
.17 STL BM: steel beam.
.18 STC: sound tranmission class.
.19 STL FL DK: steel floor deck.
.20 STL PL: steel plate.
.21 STN: stone.
.22 STR: structure or structural.
.23 ST SEW: storm sewer.
.24 S&U: stain and urethane.
.25 S&V: stain and varnish.
.26 SVT: solid vinyl tile.

.20 T:
.1 T: top.
.2 T&B: top and bottom.
.3 TCB: turbidity control plan.
.4 TEL: telephone.
.5 TER: terrazzo.
.6 TERT: terrazzo tile.
.7 THKNS: thickness.
.8 THR: threshold.
.9 TMPD: tempered.
.10 TOPG: topping.
.11 TRANSV: transverse.
.12 TYP: typical.

.21 U:
.1 U: urethane.
.2 UCUT: undercut.
.3 UGRD: underground.
.4 UNO: unless noted otherwise.
.5 UOS: unless otherwise specified.
.6 U/S: underside.
.7 UR: urinal.

.22 V:
.1 VCF: vinyl coated fabric.
.2 VCT: vinyl compositition tile.
.3 VERT: vertical.
.4 VERT B: vertical blinds.
.5 VERT EF: vertical each face.
.6 VSF: vinyl sheet flooring.
.7 VT: vinyl tile.
.8 VWC: vinyl wall covering.

.23 W:
.1 WC: water closet.
.2 W-C: wall connectors.
.3 WD: wood.
.4 WDV: wood veneer.
.5 WH: wall hydrant.
.6 WHMIS: workplace hazardous materials information system.
.7 WP: waterproofing.
.8 WR: washroom.
.9 WSIB: workplace safety and insurnace board.

.10 WT: weight.
.11 WTP: water treatment plant.

1.3 STANDARDS ORGANIZATIONS

.1 Standards writing organizations:
.1 AA - Aluminum Association.
.2 ACPA - American Concrete Pipe Association.
.3 ANSI - American National Standards Institute.
.4 ASHRAE - American Society of Heating and Refrigerating and Air-Conditioning Engineers.
.5 ASTM - American Society for Testing and Materials.
.6 AWI/AWMAC - Architectural Woodwork Institute/Architectural Woodwork Manufacturers Association of Canada.
.7 AWPA - American Wood Preservers' Association.
.8 AWWA - American Water Works Association.
.9 BHMA - Builders Hardware Manufacturers Association.
.10 CCDC - Canadian Construction Documents Committee.
.11 CCMPA - Canadian Concrete Masonry Producers Association.
.12 CGSB - Canadian General Standards Board.
.13 CNTA - Canadian Nursery Trades Association.
.14 CPCA - Canadian Painting Contractors Association.
.15 CRCA - Canadian Roofing Contractors Association.
.16 CSA - Canadian Standards Association.
.17 CSC - Construction Specifications Canada.
.18 CSDMA - Canadian Steel Door Manufacturers Association.
.19 CSI - Construction Specifications Institute.
.20 CSSBI - Canadian Sheet Steel Building Institute.
.21 CRCA - Canadian Roofing Contractors Association.
.22 DHI - Door and Hardware Insitute.
.23 EEMAC - Electrical and Electronic Manufacturer's Association of Canada.
.24 ESA - Electrical Safety Authority.
.25 FCC - Fire Commissioner of Canada.
.26 FSC - Forest Stewardship Council.
.27 GANA - Glass Association of North America.
.28 HMMA - Hollow Metal Manufacturers Association.
.29 IEEE - Institute of Electrical and Electronics Engineers Inc.

.30 ISO - International Organization for Standardization.
.31 IWFA - International Window Film Association.
.32 LEED - LEED Canada, Leadership in Energy and Environmental Design.
.33 MPI - Master Painters Insitute.
.34 NAAMM - National Association of Architectural Metal Manufacturers.
.35 NCPI - National Clay Pipe Institute.
.36 NEMA - National Electrical Manufacturers Association.
.37 NFPA - National Fire Protection Association.
.38 OPSD - Ontario Provincial Standard Drawings.
.39 OPSS - Ontario Provincial Standard Specifications.
.40 PPI - Plasctics Pipe Institute.
.41 SDI - Steel Door Intitute.
.42 SCAQMD - South Coast Air Quality Management District.
.43 TIA - Telecommunications Industry Association.
.44 TIAC - Thermal Insulation Association of Canada.
.45 TTMAC - Terrazzo Tile and Marble Association of Canada.
.46 UL - Underwriters Laboratories.
.47 ULC - Underwriters Laboratories of Canada.
.48 US EPA - United States Environmental Protection Agency.
.49 WH - Warnock Hersey.

1.4 FEDERAL GOVERNMENT DEPARTMENTS AND AGENGIES

.1 Departments, agencies and crown corporations.
.1 CEAA - Canadian Environmental Assessment Agency.
.2 CSC - Correctional Service Canada.
.3 CRA - Canada Revenue Agency.
.4 DND - Department of National Defence.
.5 EC - Environment Canada.
.6 FHBRO - Federal Heritage Buildings Review Office.
.7 HC - Health Canada.
.8 HCD - Heritage Conservation Directorate.
.9 LC - Labour Canada.
.10 PC - Parks Canada.
.11 PWGSC - Public Works and Government Services Canada.
.12 RCMP - Royal Canadian Mounted Police.
.13 TBS - Treasury Board Secretariat.
.14 TC - Transport Canada.

1.5 PROVINCIAL GOVERNMENT DEPARTMENTS AND AGENGIES

.1 MOEE - Ontario Ministry of Environment and Energy.

.2 MOL - Ontario Ministry of Labour.

.3 MTO and MOT - Ontario Ministry of Transportation.

.4 TSSA - Technical Standards and Safety Authority.

1.6 INTERNATIONAL GOVERNMENT DEPARTMENTS AND AGENCIES

.1 DOHMH - New York City Department of Health and Mental Hygiene, USA.

.2 GSA - Government Services Administration, USA.

1.7 UNITS OF MEASURE METRIC

.1 The following abbreviations of units of measure are commonly found in the Project Manual:

.1 C: Celsius.
.2 cm: centimetre.
.3 kg: kilogram.
.4 kg/m^3: kilogram per cubic metre.
.5 kN: kilonewton.
.6 kPa: kilopascals.
.7 kw: kilowatts.
.8 l/s: litre per second.
.9 m: metre.
.10 m^3: cubic metre.
.11 mg/kg: milligrams per kilogram.
.12 mg/L: milligrams per litre.
.13 mm: millimetres.
.14 MPa: megapascal.
.15 NTU: nephelometric turbidity unit.
.16 ppm: parts per million.
.17 ug/L: micrograms per litre.
.18 ug/m^3: micrograms per cubic metre.

1.8 UNITS OF MEASURE IMPERIAL

.1 The following abbreviations of units of measure are commonly found in the Project Manual:

.1 F: Fahrenheit.
.2 ft: foot/feet.
.3 ga: guage.
.4 gpm: gallons per minute.
.5 in: inches.
.6 lbs: pounds.
.7 NTU: nephelometric turbidity unit.
.8 psi: pounds-force per square inch.
.9 ppm: parts per million.

1.9 LEED TERMS .1 Acronyms specific to LEED:
.1 CI: commercial interiors.
.2 EQ: environmental quality.
.3 MR: material and resources.
.4 NC: new construction.

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 SECTION INCLUDES

.1 Inspection and testing, administrative and enforcement requirements.

.2 Tests and mix designs.

.3 Mill tests.

.4 Equipment and system adjust and balance.

1.2 INSPECTION

.1 Allow Departmental Representative 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 Departmental Representative 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 Departmental Representative may order any 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, Departmental Representative shall pay cost of examination and replacement.

1.4 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.

1.5 PROCEDURES

.1 Notify appropriate agency and Departmental Representative 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 an orderly sequence so as not to cause delay 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.

1.6 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 Departmental Representative 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 Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Departmental Representative may deduct from Contract Amount difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Departmental Representative.

1.7 REPORTS

.1 Submit 4 copies of inspection and test reports to Departmental Representative.

.2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested.

1.8 TESTS AND MIX DESIGNS

.1 Furnish test results and mix designs as may be requested.

.2 The cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work shall be appraised by Departmental Representative and may be authorized as recoverable.

1.10 MILL TESTS

.1 Submit mill test certificates as required of specification Sections.

1.11 EQUIPMENT AND SYSTEMS

.1 Submit testing, adjusting and balancing reports for mechanical, electrical and building equipment systems.

.2 Submit Commissioning Documentation in accordance with Section 01 91 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 SECTION INCLUDES

.1 Temporary utilities.

1.2 RELATED SECTIONS

.1 Section 01 52 00 - Construction Facilities.

.2 Section 01 56 00 - Temporary Barriers and Enclosures.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

1.4 INSTALLATION AND REMOVAL

.1 Provide temporary utilities controls in order to execute work expeditiously.

.2 Remove from site all such work after use.

1.5 WATER SUPPLY

.1 Provide continuous supply of potable water for construction use.

.2 Arrange for connection with appropriate utility company and pay all costs for installation, maintenance and removal.

.3 Pay for utility charges at prevailing rates.

1.6 TEMPORARY HEATING AND VENTILATION

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

.2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.

.3 Provide temporary heat and ventilation in enclosed areas as required to:
.1 Facilitate progress of Work.
.2 Protect Work and products against dampness and cold.
.3 Prevent moisture condensation on surfaces.
.4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.

.5 Provide adequate ventilation to meet health regulations for safe working environment.

.4 Maintain temperatures of minimum 10°C in areas where construction is in progress.

.5 Ventilating:
.1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
.2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
.4 Ventilate storage spaces containing hazardous or volatile materials.
.5 Ventilate temporary sanitary facilities.
.6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.

.6 Permanent heating system of building, may be used when available. Be responsible for damage to heating system if use is permitted.

.7 On completion of Work for which permanent heating system is used, replace filters.

.8 Ensure Date of Substantial Performance and Warranties for heating system do not commence until entire system is in as near original condition as possible and is certified by Departmental Representative.

.9 Pay costs for maintaining temporary heat, when using permanent heating system.

.10 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
.1 Conform with applicable codes and standards.
.2 Enforce safe practices.
.3 Prevent abuse of services.
.4 Prevent damage to finishes.
.5 Vent direct-fired combustion units to outside.

.11 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.7 TEMPORARY POWER AND LIGHT

.1 Provide and pay for temporary power during construction for temporary lighting and operating of power tools.

.2 Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance and removal.

.3 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx.

.4 Electrical power and lighting systems installed under this Contract may be used for construction requirements only with prior approval of Departmental Representative provided that guarantees are not affected. Make good damage to electrical system caused by use under this Contract. Replace lamps which have been used for more than 3 months.

1.9 FIRE PROTECTION

.1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.

.2 Burning rubbish and construction waste materials is not permitted on site.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Construction aids.

.2 Office and sheds.

.3 Parking.

.4 Project identification.

1.2 REFERENCE

.1 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.189-2000, Exterior Alkyd Primer for Wood.
.2 CAN/CGSB-1.59-97, Alkyd Exterior Gloss Enamel.

.2 Canadian Standards Association (CSA International)
.1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
.2 CAN/CSA-Z321-96(R2006), Signs and Symbols for the Occupational Environment, withdrawn but still available from CSA, CCOHS and Techstreet.

.3 U.S. Environmental Protection Agency (EPA)/ Office of Water
.1 EPA 833-R-06-004, May 2007, Developing Your Stormwater Pollution Prevention Plan - A Guide for Construction Sites.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

1.4 INSTALLATION AND REMOVAL

.1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.

.2 Identify areas which have to be gravelled to prevent tracking of mud.

.3 Indicate use of supplemental or other staging area.

.4 Provide construction facilities in order to execute work expeditiously.

.5 Remove from site all such work after use.

1.5 ELEVATORS

.1 Designated existing elevators may be used by construction personnel and transporting of materials. Co-ordinate use with Departmental Representative.

.2 Provide protective coverings for finish surfaces of cars and entrances.

1.6 SITE STORAGE/LOADING

.1 Confine work and operations of employees to areas defined by Contract Documents. Do not unreasonably encumber premises with products.

.2 Do not load or permit to load any part of Work with a weight or force that will endanger the Work.

1.7 CONSTRUCTION PARKING

.1 Parking will be permitted on site provided it does not disrupt performance of Work.

.2 Provide and maintain adequate access to project site.

.3 If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractors' use of roads.

.4 Clean construction runways and taxi areas where used by Contractor's equipment.

1.8 SECURITY

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

1.9 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in a clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.

.2 Locate materials not required to be stored in weatherproof sheds on site in a manner to cause least interference with work activities.

1.10 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

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

1.11 PROTECTION AND MAINTENANCE OF TRAFFIC

.1 Provide access and temporary relocated roads as necessary to maintain traffic.

.2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Departmental Representative.

.3 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

.4 Protect travelling public from damage to person and property.

.5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.

.6 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.

.7 Construct access and haul roads necessary.

.8 Haul roads: constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided.

.9 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

.10 Dust control: adequate to ensure safe operation at all times.

.11 Location, grade, width, and alignment of construction and hauling roads: subject to approval by Departmental Representative.

.12 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.

.13 Provide snow removal during period of Work.

.14 Remove, upon completion of work, haul roads designated by Departmental Representative.

1.12 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.

.3 Store materials resulting from demolition activities that are salvageable.

.4 Stack stored new or salvaged material.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Barriers.

.2 Environmental Controls.

.3 Traffic Controls.

.4 Fire Routes.

1.2 RELATED SECTIONS

.1 Section 01 51 00 - Temporary Utilities.

.2 Section 01 52 00 - Construction Facilities.

1.3 REFERENCES

.1 Canadian General Standards Board (CGSB):
.1 CAN/CGSB-1.189-2000, Exterior Alkyd Primer for Wood.
.2 CAN/CGSB-1.59-97, Alkyd Exterior Gloss Enamel.

.2 Canadian Standards Association (CSA):
.1 CSA-O121-08, Douglas Fir Plywood.

1.4 INSTALLATION AND REMOVAL

.1 Provide temporary controls in order to execute Work expeditiously.

.2 Remove from site all such work after use.

1.5 HOARDING

.1 Erect temporary site enclosures using 38 x 89 mm construction grade lumber framing at 600 mm o.c. and 1200 x 2400 x 13 mm exterior grade fir plywood to CSA-O121, at building Apply plywood panels vertically flush and butt jointed.

.2 Erect temporary site enclosure using new 1.8 m high wired fence. Provide one lockable truck gate. Maintain fence in good repair.

.3 Provide barriers around trees and plants. Protect from damage by equipment and construction procedures

1.6 DUST TIGHT SCREENS

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

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

1.7 ACCESS TO SITE

.1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

1.8 PUBLIC TRAFFIC FLOW

.1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect the public.

1.9 FIRE ROUTES

.1 Maintain access to property including overhead clearances for use by emergency response vehicles.

1.10 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

.1 Protect surrounding private and public property from damage during performance of Work.

.2 Be responsible for damage incurred.

1.11 PROTECTION OF BUILDING FINISHES

.1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.

.2 Provide necessary screens, covers, and hoardings.

.3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.

.4 Be responsible for damage incurred due to lack of or improper protection.

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 SECTION INCLUDES

.1 Product quality, availability, storage, handling, protection, and transportation.

.2 Manufacturer's instructions.

.3 Quality of Work, coordination and fastenings.

.4 Existing facilities.

1.2 RELATED SECTIONS

.1 Section 01 45 00 - Quality Control.

1.3 REFERENCES

.1 Within text of specifications, reference may be made to reference standards.

.2 Conform to these standards, in whole or in part as specifically requested in specifications.

.3 If there is question as to whether any product or system is in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.

.4 The cost for such testing will be born by Owner in event of conformance with Contract Documents or by Contractor in event of non-conformance.

.5 Conform to latest date of issue of referenced standards in effect on date of submission of Bids, except where specific date or issue is specifically noted.

1.4 QUALITY

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

.2 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.

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

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

.5 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.5 AVAILABILITY

.1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for any items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

.2 In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Amount or Contract Time.

1.6 METRIC SIZED MATERIALS

.1 SI metric units of measurement are used exclusively on the drawings and in the specifications for this project.

.2 The Contractor is required to provide metric products in the sizes called for in the Contract Documents except where a valid claim can be made that a particular product is not available on the Canadian market.

.3 Claims for exemptions from use of metric sized products shall be in writing and fully substantiated with supportive documentation. Promptly submit application to Departmental Representative for consideration and ruling. Non-metric sized products may not be used unless Contractor's application has been approved in writing by the Departmental Representative.

.4 Difficulties caused by the Contractor's lack of planning and effort to obtain modular metric sized products which are available on the Canadian market will not be considered sufficient reasons for claiming that they cannot be provided.

.5 Claims for additional costs due to provision of specified modular metric sized products will not be considered.

1.7 STORAGE, HANDLING AND PROTECTION

.1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.

.2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.

.3 Store products subject to damage from weather in weatherproof enclosures.

.4 Store cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

.9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.8 TRANSPORTATION

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

1.9 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

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

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

1.10 QUALITY OF WORK

.1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Departmental Representative if required Work is such as to make it impractical to produce required results.

.2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.

.3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

1.11 CO-ORDINATION

.1 Ensure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.

.2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.12 CONCEALMENT

.1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.

.2 Before installation, inform Departmental Representative if there is interference. Install as directed by Departmental Representative.

1.13 REMEDIAL WORK

.1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Coordinate adjacent affected Work as required.

.2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.14 LOCATION OF FIXTURES

.1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.

.2 Inform Departmental Representative of conflicting installation. Install as directed.

1.15 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.

.4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.16 FASTENINGS - EQUIPMENT

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

.2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No.304 stainless steel for exterior areas.

.3 Bolts may not project more than one diameter beyond nuts.

.4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

1.17 PROTECTION OF WORK IN PROGRESS

.1 Prevent overloading of any part of building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of Departmental Representative.

1.18 EXISTING UTILITIES

.1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants.

.2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

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.

.2 Submit written request in advance of cutting or alteration which affects:
.1 Structural integrity of elements of project.
.2 Integrity of weather-exposed or moisture-resistant elements.
.3 Efficiency, maintenance, or safety of operational elements.
.4 Visual qualities of sight-exposed elements.
.5 Work of Owner or separate contractor.

.3 Include in request:
.1 Identification of project.
.2 Location and description of affected Work.
.3 Statement on necessity for cutting or alteration.
.4 Description of proposed Work, and products to be used.
.5 Alternatives to cutting and patching.
.6 Effect on Work of Owner or separate contractor.
.7 Written permission of affected separate contractor.
.8 Date and time work will be executed.

1.2 MATERIALS

.1 Required for original installation.

.2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00.

1.3 PREPARATION

.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

.2 After uncovering, inspect conditions affecting performance of Work.

.3 Beginning of cutting or patching means acceptance of existing conditions.

.4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.

.5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

1.4 EXECUTION

.1 Execute cutting, fitting, and patching to complete Work.

.2 Fit several parts together, to integrate with other Work.

.3 Uncover Work to install ill-timed Work.

.4 Remove and replace defective and non-conforming Work.

.5 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.

.6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.

.8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.

.9 Restore work with new products in accordance with requirements of Contract Documents.

.10 Submit proposed materials, finishes and installation method for patching to Departmental Representative for approval, prior to patching.

.11 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.

.12 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

.13 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material in accordance with Section 07 84 00, full thickness of the construction element.

.14 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

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 SECTION INCLUDES

.1 Progressive cleaning.

.2 Final cleaning.

1.2 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.

.2 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.

.3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.4 Provide on-site containers for collection of waste materials and debris.

.5 Remove waste material and debris from site at end of each working day.

.6 Clean interior areas prior to start of finish work, and maintain areas free of dust and other contaminants during finishing operations.

.7 Store volatile waste in covered metal containers, and remove from premises at end of each working day.

.8 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

.9 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

.10 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.3 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 other than that caused by Owner or other Contractors.

.5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.

.6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.

.8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.

.9 Clean lighting reflectors, lenses, and other lighting surfaces.

.10 HEPA 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.

.17 Clean equipment and fixtures to a sanitary condition; clean or replace filters of mechanical equipment.

.19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

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 AND DECLARATION

.1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
.1 Notify Departmental Representative in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.
.2 Request Departmental Representative's Inspection.

.2 Departmental Representative's Inspection: Departmental Representative and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.

.3 Completion: submit written certificate that following have been performed:
.1 Work has been completed and inspected for compliance with Contract Documents.
.2 Defects have been corrected and deficiencies have been completed.
.3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
.5 Operation of systems have been demonstrated to Owner's personnel.
.6 Work is complete and ready for final inspection.

.4 Final Inspection: when items noted above are completed, request final inspection of Work by Departmental Representative and Contractor. If Work is deemed incomplete by Departmental Representative, complete outstanding items and request reinspection.

1.2 CLEANING

.1 In accordance with Section 01 74 11.

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 SECTION INCLUDES

.1 As-built, samples, and specifications.

.2 Equipment and systems.

.3 Product data, materials and finishes, and related information.

.4 Operation and maintenance data.

.5 Spare parts, special tools and maintenance materials.

.6 Warranties and bonds.

.7 Final site survey.

1.2 RELATED SECTIONS

.1 Section 01 91 00 - Commissioning - General Requirements.

.3 Section 01 79 00 - Demonstration and Training.

1.3 SUBMISSION

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

.3 Revise content of documents as required prior to final submittal.

.4 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, five final copies of maintenance manuals and commissioning documentation in English.

.5 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.

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

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

.8 Pay costs of transportation.

1.4 FORMAT

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

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used, correlate data into related consistent groupings. 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.

1.5 CONTENTS - EACH VOLUME

.1 Table of Contents: provide title of project;
.1 date of submission; names,
.2 addresses, and telephone numbers of Contractor with name of responsible parties;
.3 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 clearly 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, incorporating manufacturer's instructions specified in Section 01 45 00.

.6 Training: Refer to Section 01 79 00.

1.6 AS-BUILTS AND SAMPLES

.1 In addition to requirements in General Conditions, maintain at the site for Owner one record copy of:
.1 Contract Drawings.
.2 Specifications.
.3 Amendments.
.4 Change Orders and other modifications to the Contract.
.5 Reviewed shop drawings, product data, and samples.
.6 Field test records.
.7 Inspection certificates.
.8 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 Departmental Representative.

.6 Turn one set, paper copy and electronic copy, of AS-BUILT drawings and specifications over to Departmental Representative on completion of work.

.7 If project is completed without significant deviations from Contract drawings and specifications submit to Departmental Representative one set of drawings and specifications marked "AS-BUILT".

1.7 RECORDING ACTUAL SITE CONDITIONS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Departmental Representative.

.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: legibly 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: legibly 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 Amendments and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.8 FINAL SURVEY

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

1.9 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 coordination drawings, with installed colour coded piping diagrams.

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

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

.14 Include test and balancing reports as specified in Section 01 45 00 and 01 91 00.

.15 Additional requirements: As specified in individual specification sections.

1.10 MATERIALS AND FINISHES

.1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional Requirements: as specified in individual specifications sections.

1.11 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, location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

1.12 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, location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

1.13 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, location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.14 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 Departmental Representative.

1.15 WARRANTIES AND BONDS

.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 the applicable item of work.

.4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Certificate of Substantial Performance is determined.

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

.6 Co-execute submittals when required.

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

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 SECTION INCLUDES

.1 Procedures for demonstration and instruction of equipment and systems to Owner's O&M personnel.

.2 O&M personnel includes property facility manager, building operators, maintenenace staff, security staff and technical specialists, as applicable.

1.2 RELATED SECTIONS

.1 Section 23 08 00 - Mechanical Commissioning.

1.3 DESCRIPTION

.1 Demonstrate scheduled operation and maintenance of equipment and systems to Departmental Representative's personnel two weeks prior to date of substantial performance.

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

1.4 QUALITY CONTROL

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

.2 Submit training schedule of time and date for demonstration and training of each item of equipment and each system in accordance with the training plan four weeks prior to designated dates, for Departmental Representative's approval.

.3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.

.4 Report shall give time and date of each demonstration and training, with list of persons present.

1.5 CONDITIONS FOR DEMONSTRATIONS

.1 Equipment has been inspected and put into operation.

.2 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 00 and equipment and systems are fully operational.

.3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.6 PREPARATION

.1 Verify that conditions for demonstration and instructions comply with requirements.

.2 Verify that designated O&M personnel are present.

1.7 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 designated location.

.2 Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.

.3 Review contents of manual in detail to explain all aspects of operation and maintenance.

.4 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.

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 APPLICABLE STANDARDS

.1 PWGSC Commissioning Manual (CP.1) and Guidelines (CP.3 to CP.13), latest edition.

.2 CSA Z320-11 – Building Commissioning Standard and Check Sheets.

.3 PWGSC MD 15000 - Mechanical Environmental Standards for Federal Office Buildings.

.4 PWGSC MD 15116 – Computer Room Air-conditioning.

.5 PWGSC MD 15128 - Laboratory Fume Hoods.

.6 PWGSC MD 15161 - Design Guideline for Control of Legionella.

.7 PWGSC MD 15200 - Re-Commissioning Manual for Buildings 2011.

.8 Government of Canada Workplace 2.0 Fit-up Standards - April 2012.

.9 Canadian Biosafety Standards and Guidelines, first edition.

.10 CAN CSA-B651-12 - Accessible Design for the Built Environment.

.11 CAN/ULC-S536-04 – Inspection and Testing of Fire Alarm Systems.

.12 CAN/ULC-S537-04 – Verification of Fire Alarm Systems.

.13 CSA C22.2 No.151-M1986 (R2004) Laboratory Equipment.

.14 CSA Z316.5-04 (R2009) - Fume Hoods and Associated Exhaust Systems.

.15 ASHRAE Guideline 0-2005 – The Commissioning Process.

.16 ASHRAE Guideline 1.1-2007 – The HVAC Commissioning Process.

.17 ASHRAE/IES Standard 202-2013 – Commissioning Process for Buildings and Systems.

.18 NEBB Procedural Standards for Whole Building Systems Commissioning.

.19 NEBB Procedural Standards for Fume Hood Performance Testing.

.20 AABC National Standards for Total System Balance 2002.

.21 AABC Test and Balance Procedures.

1.2 DESCRIPTION

.1 Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. The commissioning process begins in the design phase and continues through construction, acceptance and the warranty period. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, functional testing and training.

.2 Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

.1 Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and industry best practices, and that they receive adequate operational checkout by installing contractors.

.2 Verify and document proper performance of equipment and systems.

.3 Verify that O&M documentation left on site is complete.

.4 Verify that the Owner's operating personnel are adequately trained.

.3 The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.3 ABBREVIATIONS

.1 The following are common abbreviations used in the Specifications and in the Commissioning Plan. Definitions are found in Section 1.8.

A/E-	Architect and Design Engineers	FT-	Functional performance test
CA-	Commissioning Authority	GC-	General Contractor
CC	Controls Contractor	MC-	Mechanical Contractor
PM-	Project Manager (of the GC)	PC-	Pre-functional checklists
Cx-	Commissioning	Subs-	Subcontractors to General
Cx Plan-	Commissioning Plan document	TAB-	Test and Balance Contractor
EC-	Electrical Contractor	FM	Facility Management

1.4 COORDINATION

.1 Commissioning Team. The commissioning team consists of the representatives from the Owner, the Facility Management (FM) Staff, Commissioning Authority (CA), the Project Manager (PM), the General Contractor (GC or Contractor), the Architect and Design Engineers (A/E), the Mechanical Contractor (MC), the Electrical Contractor (EC), the Testing and Balancing (TAB) Contractor, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment.

.2 Management. The CA is hired by the Owner and follows the rules of an Independent Commissioning Authority. The CA directs and coordinates the commissioning activities and reports to the Owner or the Project Manager (PM). All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

.3 Scheduling. The CA will work with the PM and GC according to established protocols to schedule the commissioning activities. The CA will provide sufficient notice to the PM and GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process. The CA will work with the GC to provide the initial schedule of primary commissioning events at the commissioning scoping meeting. The commissioning Plan provides a format for this schedule. As construction progresses more detailed schedules are developed by the GC and the CA. The Commissioning Plan also provides a format for detailed schedules.

1.5 COMMISSIONING PROCESS

.1 Commissioning Plan. The commissioning plan provides guidance in the execution of the commissioning process. Following the commissioning scoping meeting, the CA will update the plan which is then considered the "final" plan, though it will continue to evolve and expand as the project progresses. The Specifications will take precedence over the Commissioning Plan.

.2 Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

.1 Commissioning during construction begins with a scoping meeting conducted by the CA where the commissioning process is reviewed with the commissioning team members.

.2 Additional meetings will be required throughout construction, scheduled by the CA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.

.3 Equipment documentation is submitted to the CA during normal submittals, including detailed start-up procedures and shop drawings.

.4 The CA works with the Subs in developing startup plans and startup documentation formats, including providing the Subs with pre-functional test sheets to be completed during the startup process.
.5 In general, the checkout and performance verification proceeds from simple to complex; from component level, to equipment, to systems, and finally intersystem levels with pre-functional test sheets being completed before functional testing.
.6 The Subs, under their own direction, execute and document the pre-functional test sheets and perform startup and initial checkout. The CA documents that the test sheets and startup were completed according to the approved plans. This may include the CA witnessing start-up of selected equipment.
.7 The CA develops specific equipment and system functional performance test procedures with the assistance of Subs as required. The Subs review the test procedures once prepared.
.8 The procedures are executed by the Subs, under the direction of, and documented by the CA.
.9 Items of non-compliance in material, installation or setup are corrected at the Sub's expense and the system retested.
.10 The CA reviews the O&M documentation for completeness.
.11 Commissioning is completed before Substantial Completion.
.12 Deferred testing is conducted, as specified or required.

1.6 RELATED WORK

.1 Specific commissioning requirements are given in the following sections of these specifications. All of the following sections apply to the Work of this section.

01 91 00	*Commissioning*	*Describes the commissioning process, responsibilities common to all parties, responsibilities of the A/E, CA, GC and Suppliers, focusing on the CA. The unique MC, CC, TAB and EC (including the Contractors for the Special Systems) responsibilities are included in Divisions 21, 22, 23, 25, 26, 27 and 28.*
21 13 13 *23 08 00* *25 01 11*	*Wet Pipe Sprinkler Systems* *HVAC Cx* *Start-up, Verification and Commissioning*	*Describes the Cx responsibilities of the Fire Protection, Plumbing, Mechanical, TAB and Controls Contractors and the pre-functional testing and startup responsibilities of each. Points to 01 91 00 for functional testing requirements and provides the pre-functional and the specific functional testing requirements for Division 21, 22, 23 and 25 equipment, for use on this project.*

26 08 00	*Electrical Cx*	*Describes the specific Cx responsibilities of the Division 26 contractor.*
28 31 00	*Commissioning Fire Alarm Systems*	*Describes the specific Cx responsibilities of the Division 28 contractor.*

1.7 RESPONSIBILITIES .1 General: General Commissioning Responsibilities are as follows:

.1 The responsibilities of various parties in the commissioning process are provided in this section. The responsibilities of the Mechanical Contractor and TAB are in Division 23 and controls Contractor are in Division 25; those of the Electrical Contractor in division 26, Communication in Division 27 and electronic Safety and Security in Division 28. it is noted that the services for the Project Manager, Architect, HVAC, Mechanical, and Electrical Designers/Engineers, are not provided For in this contract. That is, the Contractor is not responsible for providing services covered under these parties scope; their responsibilities are listed here to clarify the commissioning process.

.2 All Parties: Commissioning responsibilities for all parties are as follows:

.1 Attend commissioning scoping meeting and additional meetings, as necessary.

.3 Architect (of the A/E): Commissioning responsibilities of the Architect are as follows:

.1 Attend the commissioning scoping meeting and selected commissioning team meetings.

.2 Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted

.3 Provide any design narrative documentation requested by the CA.

.4 Coordinate resolution of system Deficiencies identified during commissioning, according to the contract documents.

.5 Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review the O&M manuals.

.6 Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.

.4 Mechanical and Electrical Designers/Engineers (of the A/E): Commissioning responsibilities of the Mechanical and Electrical Engineers are as follows:

.1 Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted. One site observation should be completed just prior to system startup.

.2 Provide any design narrative and sequences documentation requested by the CA. The Designers shall assist (along with the Contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

.3 Attend commissioning scoping meetings and other selected commissioning team meetings.

.4 Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.

.5 Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review the O&M manuals.

.6 From the Contractor’s red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, condenser water, domestic water, steam and condensate systems; supply, return and exhaust air systems and emergency power system.

.7 Provide a presentation at one of the training sessions for the Owner’s personnel.

.8 Witness testing of selected pieces of equipment and systems.

.9 Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.

.5 Commissioning Authority (CA): Commissioning Responsibilities of the Commissioning Authority are as follows:

.1 The CA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the General Contractor and the A/E. The primary role of the CA is to develop and coordinate the execution of a testing plan, observe and document performance that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CA.

.2 Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.

.3 Coordinate the commissioning work and, with the GC ensure that commissioning activities are being scheduled into the master schedule.

.4 Develop and issue the Commissioning Plan.

.5 Plan and conduct a commissioning scoping meeting and other commissioning meetings.

.6 Before startup, review the current control sequences and interlocks and work with Contractors and Design Engineers until sufficient clarity has been obtained, in writing, to be able to write detailed functional testing procedures.

.7 Review Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.

.8 Write and distribute pre-functional tests and test sheets.
.9 Develop an enhanced start-up and initial systems checkout plan with Subs.
.10 Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assisting resolving any discrepancies.
.11 Witness all or part of the HVAC piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Notify the owner and/or the PM of any deficiencies in results or procedures.
.12 Witness all or part of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Notify the owner and/or the PM of any deficiencies in results or procedures.
.13 Approve pre-functional tests and checklist completion by reviewing pre-functional checklist reports and by selected site observation and spot checking.
.14 Approve systems start-up by reviewing start-up reports and by selected site observation.
.15 Review TAB execution plan.
.16 Oversee sufficient functional testing of the control system and approve it to be used for TAB, before TAB is executed.
.17 Review air and water systems balancing by spot testing, by reviewing completed reports, and by selected site observation.
.18 With necessary assistance and review from installing Contractors, write the functional performance test procedures for equipment and systems. This may include energy management control system trending, stand-alone data-logger monitoring, or manual functional testing.
.19 Analyze any functional performance trend logs and monitoring data to verify performance.
.20 Coordinate, witness and approve manual functional performance tests performed by installing contractors.

Coordinate retesting as necessary until satisfactory performance is achieved. Perform actual functional testing with contractors on equipment so specified in Section 01 91 00 sub-section 1.9.
.21 Maintain a master deficiency and resolution log and a separate testing record. Provide the PM with written progress reports and test results with recommended actions.
.22 Witness performance testing of owner contracted tests or tests by manufacturer's personnel over which the CA may not have direct control. Document these tests and include this documentation in Commissioning Binders.
.23 Review equipment warranties to ensure that The Owner's responsibilities are clearly defined.
.24 Oversee and approve the training of the Owner's operating personnel. Compile and maintain a commissioning record book(s).
.25 Review the preparation of the O&M manuals. Provide a final commissioning report (as described in this section).
.26 Coordinate and supervise required seasonal or deferred testing and deficiency corrections.

.6 Project Manager (PM):Commissioning Responsibilities of the Project Manager are as follows:
.1 Facilitate the coordination of the commissioning work by the CA, and ensure that commissioning activities are being scheduled into the master schedule.
.2 Review the final Commissioning Plan.
.3 Attend a commissioning scoping meeting and other commissioning team meetings.
.4 Include the cost of commissioning in the total contract price.
.5 Perform the normal review of Contractor submittals.
.6 Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CA.

.7 In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.
.8 Ensure that all Subs execute their commissioning responsibilities according to the Contract Documents and schedule.
.9 Observe and witness pre-functional test sheets, startup and functional testing.
.10 Review commissioning progress and deficiency reports.
.11 Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
.12 Sign-off on individual commissioning tests as completed and passing.
.13 Coordinate the training of owner personnel.
.14 Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions according to the Final Commissioning Program.
.15 Assist the CA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.
.16 Ensure that Subs execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.
.17 Ensure that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

.7 Equipment Suppliers: Commissioning Responsibilities of the Equipment Suppliers are as follows:
.1 Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
.2 Assist in equipment testing per agreements with Subs, which may include factory tests and the development of associated reports.
.3 Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for used by the CA.

.4 Through the Contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.
.5 Provide information requested by CA regarding equipment sequence of operation and testing procedures.
.6 Review test procedures for equipment installed by factory representatives.

1.8 DEFINITIONS

.1 Approval – acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.

.2 Architect / Engineer (A/E) - the prime consultant (architect) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.

.3 Basis of Design - The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. The basis of design is the technical response to the design intent.

.4 Commissioning Authority (CA) – The CA works independent of the design and constructions teams. The CA directs and coordinates the day-to-day commissioning activities. The CA does not take an oversight role like the PM. The CA is part of the Project Manager (PM) team or shall report directly to the PM.

.5 Commissioning Plan - an overall plan that provides the structure, schedule and coordination planning for the commissioning process.

.6 Contract Documents - the documents binding on parties involved in the construction of this project (drawings, specifications, change orders, amendments, contracts, Cx Plan, etc.).

.7 Contractor - the general contractor or authorized representative.

.8 Control system - the central building energy management control system.

.9 Data-logging - monitoring flows, currents, status, pressures, etc. of equipment using

stand-alone data-loggers separate from the control system.

.10 Deferred Functional Tests – FT's that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.

.11 Deficiency - a condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not compliant with the design intent).

.12 Design Intent (Owner's Project Requirements) - a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.

.13 Design Narrative or Design Documentation - sections of either the Design Intent or Basis of Design.

.14 Factory Testing - testing of equipment on-site or at the factory by factory personnel with an Owner's representative present.

.15 Functional Test (FT) - test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low

cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB Contractor's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. FTs are performed after pre-functional test sheets and startup are complete.

.16 General Contractor (GC) - the prime contractor for this project. Generally refers to all the GC's subcontractors as well. Also referred to as the Contractor in some contexts.

.17 Manual Test - using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

.18 Monitoring - the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data-loggers or the trending capabilities of control systems.

.19 Non-Compliance - see Deficiency.

.20 Non-Conformance - see Deficiency.

.21 Over-written Value - writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50F to 75F to verify economizer operation). See also "Simulated Signal."

.22 Owner-Contracted Tests - tests paid for by the Owner outside the GC's contract and for which the CA does not oversee. These tests will not be repeated during functional tests if properly documented.

.23 Phased Commissioning - commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling time.

.24 Pre-functional Checklist (PC) - a list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the CA to the Sub. Pre-functional test sheets are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels satisfactory, labels affixed, gages in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). Pre-functional refers to before functional testing and are to be completed by the installing contractor. Pre-functional test sheets augment and are combined with the manufacturer’s start-up checklist. The CA may choose to witness pre-functional tests for large/critical pieces of equipment.

.25 Project Manager (PM) - the General Contractor’s representative in the day-to-day activities of construction.

.26 Sampling. - functionally testing only a fraction of the total number of identical or near identical pieces of equipment. Refer to Section 01910, Part 3.5.9.8 for details.

.27 Seasonal Performance Tests - FT's that are deferred until the system(s) will experience conditions closer to their design conditions.

.28 Simulated Condition - condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).

.29 Simulated Signal - disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.

.30 Specifications - the construction specifications of the Contract Documents.

.31 Startup - the initial starting or activating of dynamic equipment, including executing pre-functional test sheets.

.32 Subs - the subcontractors to the GC who provide and install building components and systems.

.33 Test Procedures - the step-by-step process which must be executed to fulfill the test requirements. The test procedures are developed by the CA.

.34 Test Requirements - requirements specifying what modes and functions, etc. shall be tested. The test requirements are not the detailed test procedures. The test requirements are specified in the Contract Documents (Sections 15995 & 16995.

.35 Trending - monitoring using the building control system.

.36 Vendor - supplier of equipment.

.37 Warranty Period - warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.9 SYSTEMS TO BE COMMISSIONED

.1 Systems to be commissioned have been detailed below:
- .1 Building Automation System
- .2 Fume Hoods
- .3 Hot Water Reheat Coils
- .4 Air Flow Valves
- .5 Cooling Coil
- .6 Humidifiers
- .7 Panelboards
- .8 Lighting Control

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

.1 All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Division Contractor for the equipment being tested. For example, the HVAC Contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC system and controls systems except for equipment specific to and used by TAB in their commissioning responsibilities.

.2 Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone datalogging equipment that may be used by the CA.

.3 Data-logging equipment and software required to test equipment will be provided by the CA, but shall not become the property of the Owner.

.4 All testing equipment shall be of sufficient readily available. quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to accuracy of 0.28°C (0.5°F) and a resolution of ± 0.056°C (0.1°F). Pressure sensors shall have an accuracy of ± 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 – EXECUTION

3.1 MEETINGS

.1 The CA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CA. Information gathered from this meeting will allow the CA to create the Commissioning Plan to its "final" version, which will also be distributed to all parties.

.2 Miscellaneous Meetings. Other meetings will be planned and conducted by the CA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CA will plan these meetings and will minimize unnecessary time being spent by Subs.

3.2 REPORTING

.1 The CA will provide regular reports to the PM and/or the owner, depending on the management structure, with increasing frequency as construction and commissioning progresses. Standard forms are provided and referenced in the Commissioning Plan.

.2 The CA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.

.3 Testing or review approvals and non-Conformance and deficiency reports are made regularly with the review and testing as described in later sections.

.4 A final summary report developed by the CA will be provided to the PM and/or the owner, focusing identifying areas where the process could be improved. Pre-functional test sheets and functional tests will not be part of the final report, but will be stored in the Commissioning Binders.

3.3 SUBMITTALS

.1 Contractors will provide the CA standard submittals required to facilitate the commissioning work. This process will be integrated into the normal submittal process and protocol of the construction team. At a minimum, the submittals will include equipment shop drawings, the manufacturer’s printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings, and details of owner contracted tests. In addition, the installation and checkout materials that are shipped inside the equipment and the field checkout forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority. All documentation requested by the CA will be included by the Subs in their O&M manual contributions.

.2 The Commissioning Authority will review submittals related to the commissioned equipment for conformance owner’s project requirements as they relate to the commissioning process.

.3 The CA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.

.4 These submittals to the CA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CA will review them.

3.4 START-UP, PREFUNCTIONAL TEST SHEETS AND INITIAL CHECKOUT

.1 The following procedures apply to all equipment to be commissioned. Some systems that are not comprised so much of actual dynamic machinery (e.g. electrical system power quality) may have very simplified PCs and startup.

.1 General. Pre-functional test sheets are a critical commissioning piece in order to ensure functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

.2 Start-up and Initial Checkout Plan. The CA shall assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the CA in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been completed. Parties responsible for pre-functional test sheets and startup are identified in the commissioning scoping meeting and in the checklist forms. The parties responsible for executing functioning performance testing are detailed in specific commissioning specification sections (refer to Section 01910 subsection 1.6 of this document for details).

.3 Pre-functional test scripts are provided by the CA to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.

.4 The subcontractor responsible for the purchase of the equipment develops the full start-up plan by combining (or adding to) the CA's test sheets with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include test sheets and procedures with specific boxes or

lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. The full start-up plan could consist of something as simple as:

.1 The CA's pre-functional test sheets.

.2 The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.

.3 The manufacturer's normally used field checkout sheets.

.5 The subcontractor submits the full startup plan to the CA for review.

.6 The CA reviews the procedures and the format for documenting them, noting any procedures that need to be added.

.7 The full start-up procedures and the approval form may be provided to the PM for review depending on management protocol.

.2 Sensor and Actuator Calibration:

.1 All field-installed temperature, relative humidity, CO/CO2, and pressure sensors/gauges, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if accepted by the Owner in advance. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

.2 All procedures used shall be fully documented on the pre-functional test sheets or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.

.3 Sensor Calibration Methods:

.1 All Sensors Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure.

.2 Sensors Without Transmitters--Standard Application. Make a reading with a

calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or Building Automation System (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.

.3 Sensors With Transmitters--Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

.4 Tolerances, Standard Applications

Sensor	**Required Tolerance [+/-]**
Cooling coil, chilled and condenser water temps	0.22°C (0.4°F)
AHU wet bulb or dew point	1.11°C (2.0°F)
Hot water coil and boiler water temp	0.83°C (1.5°F)
Outside air, space air, duct air temps	0.22°C (0.4°F)
Watt hour, voltage & amperage	1% of design
Pressures, air, water and gas	3% of design
Flow rates, air	10% of design

Sensor	**Required Tolerance (+/-)**
Flow rates, water Relative humidity	4% of design 4% of design
Combustion flue temps	2.78°C (5.0°F)
Oxygen or CO_2 monitor	0.1 % pts
CO monitor	0.01 % pts
Natural gas and oil flow rate	1% of design
Steam flow rate	3% of design
Barometric pressure	338.639 Pa (0.1 in. of Hg)

.5 Valve and Damper Stroke Setup and Check:

.1 EMS Readout For all valve and damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

.2 Closure for heating coil valves (NO): Set heating setpoint 11.11°C (20°F) above room temperature. Observe valve open. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set heating setpoint to 11.11°C (20°F) below room temperature. Observe the valve close. Restore to normal.

.3 Closure for cooling coil valves (NC): Set cooling setpoint 11.11°C (20°F) above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 11.11°C (20°F) below room temperature. Observe valve open. Restore to normal.

.6 Execution of Pre-functional Test Sheets and Startup:

.1 Four weeks prior to startup, the Subs and vendors schedule startup and checkout withthe PM, GC and CA. The performance of the pre-functional test sheets, startup and checkout are directed and executed by the Sub or vendor. When checking off pre-functional test sheets, signatures may be required of other Subs for verification of completion of their work.

.2 The CA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used as accepted by the PM).

.3 For lower-level components of equipment, (e.g., VAV boxes, sensors, controllers), the CA shall observe a sampling of the pre-functional and start-up procedures.

.4 The Subs and vendors shall execute startup and provide the CA with a signed and dated copy of the completed start-up and pre-functional tests and test sheets.

.5 Only individuals that have direct knowledge and witnessed that a line item task on the pre-functional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

.7 Deficiencies, Non-Conformance and Approval in Test Sheets and Startup:

.1 The Subs shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CA within two days of test completion.

.2 The CA reviews the report and submits either a non-compliance report or an approval form to the Sub or PM. The CA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The CA will involve the PM and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the test sheets and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CA recommends approval of the execution of the test sheets and startup of each system to the PM using a standard form.

3.5 FUNCTIONAL TESTING

.1 This sub-section applies to all commissioning functional testing for all divisions.

.2 Systems to be Commissioned: The list of equipment to be commissioned is detailed in specific commissioning specification sections (refer to Section 01910 subsection 1.6 of this document for details).

.3 Objectives and Scope The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

.4 In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

.5 Development of Test Procedures Before test procedures are written, the CA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements in specific commissioning specification sections (refer to Section 01910 subsection 1.6 of this document for details), the CA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor responsible to execute a test, shall provide limited assistance to the CA in developing the procedures review (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CA shall provide a copy of the test procedures to the Sub(s) who shall Review the tests for feasibility, safety, equipment and warranty protection. The CA may submit the tests to the A/E for review, if requested.

.6 The CA shall review owner-contracted, factory testing or required owner acceptance tests which the CA is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the Specifications. Redundancy of testing shall be minimized.

.7 The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

.8 The test procedure forms developed by the CA shall include (but not be limited to) the following information:
.1 System and equipment or component name(s)
.2 Equipment location and ID number
.3 Date
.4 Project name
.5 Participating parties
.6 A copy of the specification section describing the test requirements
.7 A copy of the specific sequence of operations or other specified parameters being verified
.8 Required pre-test field measurements (filled-up pre-functional tests)
.9 Instructions for setting up the test.
.10 Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
.11 Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
.12 A section for comments
.13 Signatures and date block for the CA and all participating parties.

.9 Test Methods:
.1 Test Execution Functional performance testing and verification may be achieved equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data-loggers. The CA may substitute specified methods or require an additional method to be executed, other than what was specified, with the approval of the PM. This may require a change order and adjustment in charge to the Owner. The CA will determine which method is most appropriate for tests that do not have a method specified.

.2 Simulated Conditions Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

.3 Overwritten Values Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

.4 Simulated Signals Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.

.5 Altering Setpoints Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55°F, when the outside air temperature is above 55°F, temporarily change the lockout setpoint to be 2°F above the current outside air temperature.

.6 Indirect Indicators Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during pre-functional testing.

.7 Setup Each function and test shall be

performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.

.8 Sampling Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in pre-functional checklist execution. A common sampling strategy referenced in the Specifications as the "xx% Sampling—yy% Failure Rule" is defined by the following example.

xx = the percent of the group of identical equipment to be included in each sample.

yy = the percent of the sample that if failing, will require another sample to be tested.

The example below describes a 20% Sampling—10% Failure Rule.

.9 Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the "first Sample."

.10 If 10% (yy) of the units in the first sample fail the functional performance tests, test another 20% of the group (the second sample).

.11 If 10% of the units in the second sample Fail, test all remaining units in the whole group.

.12 If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CA May stop the testing and require the responsible Sub to perform and document a Checkout of the remaining units, prior to continuing with functionally testing the remaining units.

.10 Coordination and Scheduling:

.1 The Subs shall provide sufficient notice To the CA regarding their completion schedule for the pre-functional test

sheets and startup of all equipment and systems. The CA will schedule functional tests through the PM, GC and affected Subs. The CA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.
.2 In general, functional testing is conducted after pre-functional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

.11 Test Equipment: Refer to Section 01910, Part 2 for Test equipment requirements.

.12 Problem Solving: The CA will recommend solutions to problems found, however it is the responsibility of the A/E, subs, and the GC to solve, correct and retest problems.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

.1 Documentation: The CA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the PM for review and to the Subs for review. The CA will include the filled out forms in the Commissioning Binders.

.2 Non-Conformance:
.1 All deficiencies or non-conformance issues shall be noted and reported to the PM on a standard non-compliance form.
.2 Corrections of minor deficiencies identified may be made during the tests at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form.
.3 Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues.

.4 As tests progress and a deficiency is identified, the CA discusses the issue with the executing contractor.

.1 When there is no dispute on the deficiency and the Sub accepts responsibility to correct, the following course of action occurs:

.2 The CA documents the deficiency in deficiency tracking log and issues to the Project Team. The Sub corrects the issue and signs off on the deficiency tracking log indicating the issue has been resolved

.3 The CA reschedules the test and the test is repeated. If the test is successful, the CA closes the item.

.5 If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

.1 The deficiency shall be documented on the deficiency tracking log with the Sub's response and a copy given to the PM and to the Sub representative assumed to be responsible.

.2 Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Project Manager.

.3 The CA documents the resolution process.

.4 Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs off on the deficiency tracking log and provides it to the CA. The CA reschedules the test and the test is repeated until satisfactory performance is achieved, at which time the CA closes the item.

.6 Cost of Retesting:

.1 The cost for the Sub to retest a Pre-functional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.

.2 For a deficiency identified, not related to any Pre-functional checklist or start-up fault, the following shall apply: The CA and PM will direct the retesting of the equipment once at no "charge" to the GC for their time. However, the CA's and PM's time for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.

.3 The time for the CA and PM to direct any retesting required because a specific Pre-functional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be backcharged to the GC, who may choose to recover costs from the party responsible for executing the faulty Pre-functional test.

.4 Refer to the sampling section of Section 01910, Part 3.6 for requirements for testing and retesting identical equipment.

.7 The Contractor shall respond in writing to the CA and PM at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.

.8 The CA retains the original deficiency tracking log until the end of the project.

.9 Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.

.3 Approval:

.1 The CA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CA and by the PM, if necessary. The CA recommends acceptance of each test to the PM using a standard form. The PM gives final approval on each test using the same form, providing a signed copy to the CA and the Contractor.

3.7 OPERATION AND MAINTENANCE MANUALS

.1 The specific content and format requirements for the standard O&M manual are detailed in Mechanical & Electrical Specifications by the Design Engineers.

.2 A/E Contribution The A/E will include in the beginning of the O&M manuals a separate section describing the systems including:
.1 The design intent narrative prepared by the A/E and provided as part of the bid documents, updated to as-built status by the A/E.
.2 Simplified professionally drawn single line system diagrams on 215.9mm x 279.4mm (8 ½" x 11") or 279.4mm x 431.8mm (11" x 17") sheets. These shall include chilled water system water system, heating system, steam system, supply air systems, exhaust systems, domestic hot water and electrical single lines. These shall show major pieces of equipment.
.3 CA Review Prior to substantial completion, the CA shall review the O&M manuals, documentation and redline as-builts for systems that were commissioned and to verify compliance with the Specifications. The CA will communicate deficiencies in the manuals to the PM or A/E, as requested. Upon a successful review of the corrections, the CA recommends acceptance of these sections of the O&M manuals to the PM or A/E. The CA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.

3.8 TRAINING OF OWNER PERSONNEL

.1 The GC shall be responsible for training coordination and scheduling, and ultimately for ensuring that training is completed.

.2 The CA shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and CA shall decide how rigorous the training should be for each piece of commissioned equipment. The CA shall communicate the results to the Subs and vendors who have training responsibilities.

.3 In addition to these general requirements, the detailed training requirements of Owner personnel by Subs and vendors is detailed in specific commissioning specification sections (refer to Section 01910 subsection 1.6 of this document for details).

.4 Each Sub and vendor responsible for training will submit a written training plan to the CA for review and approval prior to training. The plan will cover the following elements:

.1 Equipment (included in training)
.2 Intended audience
.3 Location of training
.4 Objectives
.5 Subjects covered (description, duration of discussion, special methods, etc.)
.6 Duration of training on each subject
.7 Instructor for each subject
.8 Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
.9 Instructor and qualifications

.5 For the primary HVAC equipment, the Controls Contractor shall provide a short discussion of the control of the equipment during the mechanical or electrical training conducted by others.

.6 The CA develops an overall training plan and coordinates and schedules, with the PM, the overall training for the commissioned systems. The CA develops criteria for determining that the training was satisfactorily completed, including attending some of the training, etc. The CA recommends approval of the training to the PM using a standard form. The PM also signs the approval form.

.7 The Mechanical & Electrical Design Engineer shall at the first training session present the overall system design concept and the design concept of each equipment section. This presentation shall include a review of all systems using the simplified system schematics (one-line drawings) including chilled water systems, heating systems, air distribution system, control system strategies, electrical distribution, fire systems, etc.

3.9 DEFERRED TESTING .1 Unforseen Deferred Tests If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of test sheets and functional testing may be delayed upon approval of the PM. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

.2 Seasonal Testing During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system’s design) shall be completed as part of this contract. The CA shall coordinate this activity. Tests will be executed,

documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CA witnessing. Any final adjustments to the O&M manuals and as-builts due to the testing will be made.

3.10 WRITTEN WORK PRODUCTS .1 The commissioning process generates a number of written work products described in various parts of the Specifications. The Commissioning Plan lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

Product	Developed By
1. Final Commissioning Plan	CA
2. Commissioning Meeting Minutes	CA
3. Commissioning Schedule	CA with GC and PM
4. Equipment documentation submittals	Subs
5. Sequence clarifications	Subs and A/E as needed
6. Pre-functional test sheets	CA
7. Startup and initial checkout plan (compilation of existing documents)	Subs and CA
8. Startup and initial checkout forms filled out	Subs
9. Final TAB report	TAB Contractor
10. Issues log (deficiencies)	CA
11. Commissioning Progress Record	CA
12. Functional test forms CA	
13. Filled out functional tests	CA
14. O&M manuals	Subs
15. Final Commissioning Documentation	CA
16. Overall training plan	CA and PM
17. Specific training agendas	Subs
18. Final commissioning report	CA
19. Misc. approvals	CA

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes.
.1 Methods and procedures for demolishing, salvaging, recycling and removing items designated to be removed in whole or in part.

1.2 REFERENCES

.1 Canadian Council of Ministers of the Environment (CCME).
.1 CCME PN1326-2009, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.

.2 Department of Justice Canada (Jus).
.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
.2 Canadian Environmental Protection Act, 1999 (CEPA), c. 33.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
.1 Material Safety Data Sheets (MSDS).

.4 Transport Canada (TC).
.1 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.

1.3 DEFINITIONS

.1 Demolition: rapid destruction of building following removal of hazardous materials.

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

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00.

.2 Coordinate submittal requirements and provide submittals required.

.3 Product Data: submit WHMIS MSDS - Material Safety Data Sheets.

.4 Shop drawings.
.1 Submit for approval drawings, diagrams or details showing sequence of demolition work and supporting structures and underpinning, where required by authorities having jurisdiction.
.2 Submit drawings stamped and signed by qualified professional engineer registered or licensed in Province of Ontario, Canada.

.5 Hazardous Materials: provide description of Hazardous Materials and Notification of Filing with proper authorities prior to beginning of Work as required.

1.5 QUALITY ASSURANCE

.1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.

.2 Site Meetings.
.1 Convene pre-installation meeting one week prior to beginning on-site installations:
.1 Verify project requirements.
.2 Review installation and substrate conditions.
.3 Co-ordination with other building subtrades.
.4 Review manufacturer's installation instructions and warranty requirements.
.2 Arrange for site visit with Departmental Representative to examine existing site conditions adjacent to demolition work, prior to start of Work.

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

1.6 DELIVERY, STORAGE AND HANDLING

.1 Perform Work in accordance with Section 01 35 43.

.2 Storage and Protection.
.1 Protect existing items designated to remain and items designated for salvage. In event of damage to such items, immediately replace or make repairs to approval of Departmental Representative and at no cost to Departmental Representative.
.2 Remove and store materials to be salvaged, in manner to prevent damage.

.3 Store and protect in accordance with requirements for maximum preservation of material.
.4 Handle salvaged materials as new materials.

1.7 SITE CONDITIONS .1 Site Environmental Requirements.
.1 Perform work in accordance with Section 01 35 43.
.2 Ensure that selective demolition work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
.3 Do not dispose of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers.
.1 Ensure proper disposal procedures are maintained throughout the project.
.4 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties.
.5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authorities.
.6 Protect trees, plants and foliage on site and adjacent properties.

.2 Existing Conditions.
.1 Remove contaminated or hazardous materials as defined by authorities having jurisdiction from site, prior to start of demolition Work, and dispose of at disposal facilities in safe manner in accordance with TDGA and other applicable regulatory requirements.
.2 List of hazardous materials:
.1 Refer to Designated Substances and Hazardous materials survey report.

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

PART 2 - PRODUCTS

2.1 EQUIPMENT

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

PART 3 - EXECUTION

3.1 PREPARATION

.1 Inspect site with Departmental Representative and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.

.2 Locate and protect utilities. Preserve active utilities traversing project in operating condition.

.3 Notify and obtain approval of utility companies before starting demolition.

.4 Disconnect and Cap Designated Mechanical Services as per drawings.
.1 Natural Gas Supply Lines: remove in accordance with gas company requirements and as per drawings.
.2 Sewer and Water Lines: remove as per drawings and securely plug to form watertight seal.

3.2 REMOVAL OF HAZARDOUS WASTES

.1 Remove contaminated or dangerous materials defined by authorities having jurisdiction, relating to environmental protection, from site and dispose of in safe manner to minimize danger at site or during disposal.

3.3 REMOVAL OPERATIONS

.1 Remove items as indicated.

.2 Do not disturb items designated to remain in place.

.3 Disposal of Material.
.1 Dispose of materials not designated for salvage or reuse on site at authorized facilities approved.

3.4 STOCKPILING

.1 Label stockpiles, indicating material type and quantity.

.2 Designate appropriate security resources/measures to prevent vandalism, damage and theft.

.3 Locate stockpiled materials convenient for use in new construction to eliminate double handling wherever possible.

.4 Stockpile materials designated for alternate disposal in location which facilitates removal from site and examination by potential end markets, and which does not impede disassembly, processing, or hauling procedures.

3.5 REMOVAL FROM SITE

.1 Remove stockpiled material as directed by Departmental Representative, when it interferes with operations of project.

.2 Remove stockpiles of like materials by alternate disposal option once collection of materials is complete.

.3 Transport material designated for alternate disposal using approved haulers in accordance with applicable regulations.

.4 Dispose of materials not designated for alternate disposal in accordance with applicable regulations..

3.6 RESTORATION

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

.2 Use soil treatments and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

3.7 CLEANING

.1 Remove debris, trim surfaces and leave work site clean, upon completion of Work.

.2 Use cleaning solutions and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

3.8 General Notes

.1 The building will remain occupied during all demolition and construction. Provide temporary dustproof partitions to maintain an airtight seal separating all areas of work from occupied areas. Ensure that occupied areas of the building remain free from any dust or other debris as well as noise, prior to and during demolition and construction. Assume Full responsibility for the protection of existing equipment and/or materials from damage due to construction and/or demolition operations. do not transport demolished materials through occupied areas other than those denoted. All noisy work is to be done on evenings and weekends. Contractor to clean all areas of work prior to turnover of space back to the client and on a daily basis.

.2 Unless noted otherwise, all removed and demolition materials are to be removed from site and disposed of in an approved manner. Coordinate with owner exact locations of dumpster(s) and storage of re-used equipment and/or materials, prior to placement.

.3 Where existing grounds and buildings are affected by work of contract (including, but not limited to supply and removal of dumpsters, vehicular traffic, etc.), reinstate grade and sod c/w 4" topsoil and sod and clean and reinstate all existing surfaces of building to match existing. Protect asphalt at all times during construction and demolition. Rectify any and all damage to asphalt at no cost to owner.

.4 All salvageable materials and/or equipment, furnishings, etc from demolition operations to remain property of owner as denoted on drawings. Co-ordinate with owner items to be removed off site and items to be re-used, relocated and where they are to be temporarily stored. (Refer to note no.2)

.5 Where smoke detectors, heat detectors, exit lights, emergency battery back up lighting and other fire alarm components are to remain or removed and reinstalled, contractor to make provisions to ensure all components are protected from damage that may occur during the construction phase (i.e. dust control, etc.) and that they are fully functional before turn over to the owner for use during normal working hours, and recommissioned at end of project

.6 Demolition types and existing conditions indicated on the drawings are approximate only, intended as a general indication of site conditions. Site verify and assume responsibility for all existing conditions prior to starting work.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 04 05 12 - Mortar and Masonry Grout

.2 Section 04 05 19 - Masonry Anchorage and Reinforcing.

.3 Section 04 05 23 - Masonry Accessories.

.4 Section 04 22 00 - Concrete Unit Masonry.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CAN/CSA-A165 Series-04(R2009), Standards on Concrete Masonry Units.
.2 CAN/CSA-A179-04(R2009), Mortar and Grout for Unit Masonry.
.3 CAN/CSA-A371-04(R2009), Masonry Construction for Buildings.

.2 International Masonry Industry All-Weather Council (IMIAC)
.1 Recommended Practices and Guide Specification for Hot and Cold Weather Masonry Construction.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation meetings: comply with Section 01 31 19. Conduct pre-installation meeting one week prior to commencing work to:
.1 Verify project requirements.
.2 Verify substrate conditions.
.3 Co-ordinate products, installation methods and techniques.
.4 Sequence work of related sections.
.5 Co-ordinate with other building subtrades.
.6 Review manufacturer's installation instructions.
.7 Review masonry cutting operations, methods and tools and determine worker safety and protection from dust during cutting operations.
.8 Review warranty requirements.

1.4 ACTION SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, limitations and colours.
.2 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS) in accordance with Section 01 35 29.

.3 Samples:
.1 Provide samples as follows:
.1 Two masonry block unit specified.

.4 Shop Drawings:
.1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.2 Provide shop drawings detailing temporary bracing required, designed to resist wind pressure and lateral forces during installation.

1.5 INFORMATION SUBMITTALS

.1 Certificates: provide manufacturer's product certificates certifying materials comply with specified requirements.

.2 Test and Evaluation Reports:
.1 Test reports to certify compliance of masonry units and mortar ingredients with specified performance characteristics and physical properties.
.2 Provide data for masonry units, in addition to requirements set out in referenced CSA and ASTM Standards, indicating initial rates of absorption.

.3 Installer Instructions: provide manufacturer's installation instructions, including storage, handling, safety and cleaning.

.4 Manufacturer's Reports: provide written reports prepared by manufacturer's on-site personnel to include:
.1 Verification of compliance of work with Contract.
.2 Site visit reports providing detailed review of installation of work, and installed work.

1.6 CLOSEOUT SUBMITTALS

.1 Provide manufacturer's instructions for care, cleaning and maintenance of prefaced masonry units for incorporation into manual specified in Section 01 78 00.

1.7 MAINTENANCE MATERIAL SUBMITTALS

.1 Provide manufacturer's instructions in accordance with Section 01 78 00 covering maintenance requirements and parts catalogue, with cuts and identifying numbers.

1.8 QUALITY ASSURANCE

.1 Qualifications: .1 Manufacturer: capable of providing field service representation during construction and approving application method.
.1 Installer: experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
.2 Masons: company or person specializing in masonry installations with 5 years documented experience with masonry work similar to this project.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials in accordance with Section 01 61 00.

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

.3 Storage and Handling Protection:
.1 Keep materials dry until use.
.2 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.

1.10 SITE CONDITIONS

.1 Ambient Conditions: assemble and erect components when temperatures are above 4°C.

.2 Weather Requirements: to CAN/CSA-A371.

.3 Cold weather requirements:
.1 To CAN/CSA-A371 with following requirements.
.1 Maintain temperature of mortar between 5°C and 50°C until batch is used or becomes stable.

.2 Maintain ambient temperature of masonry work and it's constituent materials between 5°C and 50°C and protect site from windchill.
.3 Maintain temperature of masonry above 0°C for minimum of 7 days, after mortar is installed.
.4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10°C, before applying mortar.

.2 Hot weather requirements:
.1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
.2 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

.1 Ensure manufacturer has minimum 5 years experience in manufacturing components similar to or exceeding requirements of project.

2.2 MATERIALS

.1 Masonry materials are specified in related Sections indicated in 1.1.

PART 3 - EXECUTION

3.1 INSTALLERS

.1 Experienced and qualified masons to carry out erection, assembly and installation of masonry work.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 EXAMINATION

.1 Examine conditions, substrates and work to receive work of this Section.
.1 Co-ordinate with Section 01 71 00.

.2 Examine openings to receive masonry units. Verify opening size, location, and that opening is square and plumb, and ready to receive work of this Section.
.1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.2 Proceed with installation after unacceptable conditions have been remedied.

.3 Verification of Conditions:
.1 Verify that:
.1 Substrate conditions which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of concrete block.
.2 Field conditions are acceptable and are ready to receive work.
.3 Built-in items are in proper location, and ready for roughing into masonry work.
.2 Commencing installation means acceptance of existing substrates.

3.4 PREPARATION

.1 Surface Preparation: prepare surface in accordance with manufacturer's written recommendations and co-ordinate with Section 01 71 00.

.2 Establish and protect lines, levels, and coursing.

.3 Protect adjacent materials from damage and disfiguration.

3.5 INSTALLATION

.1 Do masonry work in accordance with CAN/CSA-A371 except where specified otherwise.

.2 Build masonry plumb, level, and true to line, with vertical joints in alignment, respecting construction tolerances permitted by CAN/CSA-A371.

.3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.6 CONSTRUCTION

.1 Exposed masonry:
.1 Remove chipped, cracked, and otherwise damaged units, in accordance with CAN/CSA-A165, in exposed masonry and replace with undamaged units.

.2 Jointing:
.1 Allow joints to set just enough to remove excess water, then tool with round jointer to provide smooth, joints true to line, compressed, uniformly concave joints where concave joints are indicated.
.2 Allow joints to set just enough to remove excess water, then rake joints uniformly to 6 mm depth and compress with square tool to provide smooth, compressed, raked joints of uniform depth where raked joints are indicated.
.3 Strike flush joints concealed in walls and joints in walls to receive plaster, tile, insulation, or other applied material except paint or similar thin finish coating.

.3 Cutting:
.1 Cut out for electrical switches, outlet boxes, and other recessed or built-in objects.
.2 Make cuts straight, clean, and free from uneven edges.

.4 Building-In:
.1 Build in items required to be built into masonry.
.2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
.3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.

.5 Provision for movement:
.1 Leave 3 mm space below shelf angles.

3.7 SITE TOLERANCES

.1 Tolerances in notes to CAN/CSA-A371 apply.

3.8 FIELD QUALITY CONTROL

.1 Site Tests, Inspection: .1 Perform field inspection and testing in accordance with Section 01 45 00.
.1 Notify inspection agency minimum of 24 hours in advance of requirement for tests.

3.9 CLEANING

.1 Clean in accordance with Section 01 74 11.

.2 Progress Cleaning: in accordance with related masonry sections.

.3 Final Cleaning:
.1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
.2 Upon completion of installation and verification of performance of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA-A23.1-09/A23.2-09, Concrete materials and methods of concrete construction/Test methods and standard practices for concrete.
.2 CAN/CSA-A179-04(R2009), Mortar and Grout for Unit Masonry.
.3 CAN/CSA-A371-04(R2009, Masonry Construction for Buildings.
.4 CAN/CSA-A3000-08, Cementitious Materials Compendium; CAN/CSA-A3002-08, Masonry and Mortar Cement.

1.2 ACTION AND INFORMATIONAL

.1 Product Data: .1 Provide submittals in accordance with Section 01 33 00 .1Provide specifications and datasheets. Include product characteristics, performance criteria, and limitations.
.1 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS) in accordance with Section 01 35 29. Indicate VOC's mortar, grout, parging, colour additives and admixtures. Expressed as grams per litre (g/L).

.2 Manufacturer's Instructions:
.1 Provide manufacturer's installation instructions.

1.3 QUALITY ASSURANCE

.1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.2 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handles masonry mortar and grout materials in accordance with Section 01 61 00, supplemented as follows:

.1 Deliver prepackaged, dry-blended mortar mix to project site in labelled plastic-lined bags each bearing name and address of manufacturer, production codes or batch numbers, and colour or formula numbers.
.2 Maintain mortar, grout and packaged materials clean, dry, and protected against dampness, freezing, traffic and contamination by foreign materials.

1.5 SITE CONDITIONS

.1 Ambient Conditions: maintain materials and surrounding air temperature to:
.1 Minimum 10 degrees C prior to, during, and 48 hours after completion of masonry work.
.2 Maximum 32 degrees C prior to, during, and 48 hours after completion of masonry work.

.2 Weather Requirements: CAN/CSA-A37

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Use same brands of materials and source of aggregate for entire project.

.2 Materials shall be as specified, or approved equivalent.

.3 Aggregate: Clean, sharp and conforming to CSA A179-94.

.4 Mixing Water: From municipal supply, clear and free from deleterious substances.

.5 Portland Cement: Conforming to CAN/CSA A5-93, "Portland Cements".

.6 Hydrated Lime: Conforming to CSA A179-94.

.7 Masonry Cement: Conforming to CAN/CSA A8-93, "Masonry Cement".

.8 Colouring Pigments: Pigments constituted of ground coloured natural aggregates, colour to match existing as approved by the Owner. Ratio of colouring agent/density of Portland cement shall not exceed 10%.

.9 Mortar Mixes: To comply with the requirements of "Type N Mortar" with a compressive strength of 5.0 +/- 1.0 Mpa.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Request inspection of spaces to be grouted.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 CONSTRUCTION

.1 Do masonry mortar and grout work in accordance with CAN/CSA-A179 except where specified otherwise.

.2 Apply parging in uniform coating not less than total 10 mm thick.

3.4 MIXING

.1 All pointing mortar can be mixed using a regular paddle mixer. Only electric motor mixers are permissible. Mixers run on hydrocarbons are not permitted, due to fumes.

.2 Clean all mixing boards and mechanical mixing machine between batches.

.3 Mortar must be weaker than the units it is binding.

.4 Contractor to appoint one individual to mix mortar, for duration of project. In the event that this individual must be changed, mortar mixing must cease until the new individual is trained, and mortar mix is tested.

3.5 MORTAR PLACEMENT

.1 Install mortar to manufacturer's instructions.

.2 Install mortar to requirements of CAN/CSA-A179.

.3 Remove excess mortar from grout spaces.

3.6 GROUT PLACEMENT

.1 Install grout in accordance with manufacturer's instructions.

.2 Install grout in accordance with CAN/CSA-A179.

.3 Work grout into masonry cores and cavities to eliminate voids.

.4 Do not install grout in lifts greater than 400 mm, without consolidating grout by rodding.

.5 Do not displace reinforcement while placing grout.

3.7 FIELD QUALITY CONTROL

.1 Site Tests, Inspection: in accordance with Section 04 05 00 supplemented as follows:
.1 Test and evaluate mortar prior to construction in accordance with CAN/CSA-A179.
.2 Test and evaluate grout prior to construction to CAN/CSA-A179; test in conjunction with masonry unit sections specified.

.2 Manufacturer's Field Services: in accordance with Section 04 05 00.

3.8 CLEANING

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

.2 Remove droppings and splashings using clean sponge and water.

.3 Clean masonry with low pressure clean water and soft natural bristle brush.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM International Inc.

.1 ASTM A36/A36M-08, Standard Specification for Carbon Structural Steel.

.2 ASTM A82/A82M-07, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

.3 ASTM A167-99(R2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.4 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

.5 ASTM A580/A580M-08, Standard Specification for Stainless Steel Wire.

.6 ASTM A641/A641M-09a, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.

.7 ASTM A666-03, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

.2 Canadian Standards Association (CSA International)

.1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CAN/CSA-A179-04(R2009), Mortar and Grout for Unit Masonry.

.3 CAN/CSA-A370-04(R2009), Connectors for Masonry.

.4 CAN/CSA-A371-04(R2009), Masonry Construction for Buildings.

.5 CAN/CSA-G30.18-09, Carbon Steel Bars for Concrete Reinforcement.

.6 CSA S304.1-04, Design of Masonry Structures.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets illustrating products to be incorporated into project for specified products.

.2 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS).

.3 Manufacturer's Instructions:

.1 Provide manufacturer's installation instructions.

1.3 QUALITY ASSURANCE

.1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.2 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Section 04 05 10.

1.4 FIELD MEASUREMENTS

.1 Make field measurements necessary to ensure proper fit of members.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle masonry anchorage and reinforcing materials in accordance with Section 01 61 00, supplemented as follows:
.1 Deliver reinforcement and connectors, identified in shop and placement drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Connectors: to CAN/CSA-A370 and CSA S304.1.

.2 Corrosion protection: to CSA S304.1,

.3 Ties: hot dip galvanized to CAN/CSA-A370 Table 5.2 uncoated steel finish.
.1 Joint Reinforcement Ties: to CAN/CSA-A370:
.1 Single Wythe Joint Reinforcement: ladder type:
.1 Steel wire, hot dip galvanized: to ASTM A641, Class 3 after fabrication.
.2 Cold drawn steel wire conforming to ASTM A82/A82M.
.3 Stainless steel conforming to ASTM A580, Type 304, 4.8 mm side rods with 4.8 mm cross ties.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Supply and install masonry connectors and reinforcement in accordance with CAN/CSA-A370, CAN/CSA-A371, CSA-A23.1/A23.2 and CSA S304.1 unless indicated otherwise.

3.3 BONDING AND TYING

.1 Bond walls of two or more wythes using metal connectors in accordance with CSA S304.1, CAN/CSA-A371 and as indicated.

.2 Tie masonry veneer to backing in accordance with NBC 2010, CSA S304.1, CAN/CSA-A371 and as indicated.

.3 Install unit, adjustable, single wythe and multiple wythe joint reinforcement where indicated and in accordance with CAN/CSA-A370 and CAN/CSA-A371 and manufacturer's instructions.
.1 Install horizontal joint reinforcement 400 mm on centre.

3.4 GROUTING

.1 Grout masonry in accordance with CSA S304.1, CAN/CSA-A371 and CAN/CSA-A179 and as indicated.

3.5 ANCHORS

.1 Supply and install metal anchors in accordance with CAN/CSA-A370 and CAN/CSA-A371.

3.6 LATERAL SUPPORT AND ANCHORAGE

.1 Supply and install lateral support and anchorage in accordance with CSA S304.1 and as indicated.

3.7 MOVEMENT JOINTS

.1 Reinforcement will not be continuous across movement joints unless otherwise indicated.

3.8 FIELD BENDING

.1 Do not field bend reinforcement and connectors except where indicated or authorized by Departmental Representative.

.2 When field bending is authorized, bend without heat, applying a slow and steady pressure.

.3 Replace bars and connectors which develop cracks or splits.

3.9 FIELD QUALITY CONTROL

.1 Site inspections in accordance with Section 01 11 01.

3.10 FIELD TOUCH-UP

.1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcement steel and connectors with compatible finish to provide continuous coating.

3.11 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM International Inc.
.1 ASTM D2240-05(2010), Standard Test Method for Rubber Property - Durometer Hardness.

.2 Canadian Standards Association (CSA International)
.1 CAN/CSA-A371-04(R2009), Masonry Construction for Buildings.
.2 CAN/CSA-ISO 14021-00(R2009), Environmental Labels and Declarations - Self Declared Environmental Claims (Type II Environmental Labelling).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:
.1 Provide manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.

.3 Shop Drawings:
.1 Provide shop drawings in accordance with Section 01 33 00.
.1 Provide drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada.
.2 Shop drawings consist of flashing and installation details. Indicate sizes, spacing, location and quantities of fasteners.

.4 Samples:
.1 Provide masonry accessory samples in accordance with Section 01 33 00, supplemented as follows:
.1 Materials: two samples, illustrating colour and colour range. Include:
.1 Movement joint filler.
.2 Lap adhesive.
.3 Mechanical fasteners.
.4 Reglets.
.5 Brick vents.

.5 Quality Assurance Submittals:
.1 Test reports: submit certified test reports in accordance with Section 04 05 00
.2 Certificates: submit in accordance with Section 04 05 00.

.3 Pre-installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.
.4 Manufacturer's Instructions: submit in accordance with Section 04 05 00

.6 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

.7 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.8 Pre-installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Section 04 05 00.

1.3 FIELD MEASUREMENTS

.1 Make field measurements necessary to ensure proper fit of members.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle masonry accessories in accordance with, Section 01 61 00 supplemented as follows:
.1 Keep fillers and adhesives dry, protected against dampness, and freezing.
.2 Store packaged materials off ground and in accordance with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Mechanical fasteners: recommended by flashing manufacturer to suit project requirements.

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.

3.4 CLEANING

.1 Clean in accordance with Section 01 74 11.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM International Inc.
.1 ASTM E336-11, Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.

.2 Canadian Standards Association (CSA International)
.1 CAN/CSA-A165 Series-04(R2009), CSA Standards on Concrete Masonry Units (covers: A165.1, A165.2, A165.3).
.2 CAN/CSA-A371-04(R2009), Masonry Construction for Buildings.
.3 CSA S304.1-04(R2010), Design of Masonry Structures.

.3 Underwriters' Laboratories of Canada (ULC)
.1 CAN-ULC-S101-07, Standard Methods of Fire Endurance Tests of Building Construction and Materials.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:
.1 Product Data: provide product data, including manufacturer's printed data sheets and catalog pages illustrating products to be incorporated into project for specified products.

.3 Samples:
.1 Provide unit samples in accordance with Section 04 05 10.

.4 Manufacturer's Written Instructions: provide in accordance with Section 04 05 10.

1.3 QUALITY ASSURANCE SUBMITTALS

.1 Certificates: provide in accordance with Section 04 05 10.

.2 Test and Evaluation Reports: provide certified test reports in accordance with Section 04 05 10.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle concrete unit masonry in accordance with Section 04 05 00.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Standard concrete block units: to CAN/CSA-A165 Series (CAN/CSA-A165.1). Confirm exact size, thickness and profile

2.2 REINFORCEMENT

.1 Reinforcement in accordance with Section

2.3 MORTAR MIXES

.1 Mortar and mortar mixes in accordance with Section 04 05 12.

2.4 GROUT MIXES

.1 Grout and grout mixes in accordance with Section 04 05 12.

2.5 CLEANING COMPOUNDS

.1 Use low VOC products in compliance with SCAQMD Rule 1168.

.2 Compatible with substrate and acceptable to masonry manufacturer for use on products.

.3 Cleaning compounds compatible with concrete unit masonry and in accordance with manufacturer's written recommendations and instructions.

2.6 TOLERANCES

.1 Tolerances for standard concrete unit masonry tolerances in accordance with CAN/CSA-A165.1, supplemented as follows:
.1 Maximum variation between units within specific job lot not to exceed 2 mm.
.2 No parallel edge length, width or height dimension for individual unit to differ by more than 2 mm.
.3 Out of square tolerance not to exceed 2 mm.

.2 Tolerances for architectural concrete masonry units in accordance with CAN/CSA-A165.1, supplemented as follows:
.1 Maximum variation in length or height between units within specific job lot for specified dimension not to exceed 2 mm.
.2 No parallel edge length, width or height dimension for individual unit to differ by more than 2 mm.

.3 Out of square tolerance not to exceed 2 mm.
.4 Maximum variation in width between units within specific job lot for specified dimension not to exceed 2 mm.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verify surfaces and conditions are ready to accept work of this Section.

.2 Commencing installation means acceptance of existing substrates.

3.2 PREPARATION

.1 Protect adjacent finished materials from damage due to masonry work.

3.3 INSTALLATION

.1 Concrete block units:
.1 Bond: to match existing.
.2 Coursing height: to match existing
.3 Jointing: to match existing where exposed or where paint or other finish coating is specified.

3.4 REINFORCEMENT

.1 Install reinforcing in accordance with Section 04 05 19.

3.5 CONNECTORS

.1 Install connectors in accordance with Section 04 05 19.

3.6 MORTAR PLACEMENT

.1 Place mortar in accordance with Section 04 05 12.

3.7 GROUT PLACEMENT

.1 Place grout in accordance with Section 04 05 12.

3.8 CONSTRUCTION

.1 Cull out masonry units, in accordance with CAN/CSA-A165 and reviewed range of colour samples, with chips, cracks, broken corners, excessive colour and texture variation.

.2 Build in miscellaneous items such as bearing plates, steel angles, bolts, anchors, inserts, sleeves and conduits.

.3 Build around frames previously set and braced. Fill behind hollow frames within masonry walls with mortar or grout and embed anchors.

.4 Fit masonry closely against electrical and plumbing outlets so collars, plates and covers overlap and conceal cuts.

.5 Install movement joints and keep free of mortar where indicated.

.6 Hollow Units: spread mortar setting bed from outside edge of face shells. Gauge amount of mortar on top and end of unit to create full joints, equivalent to shell thickness. Avoid excess mortar.

.7 Solid Units: apply mortar over entire vertical and horizontal surfaces. Avoid bridging of airspace between brick veneer and backup wall with mortar.

.8 Ensure compacted head joints. Use full or face-shell joint as indicated.

.9 Tamp units firmly into place.

.10 Do not adjust masonry units after mortar has set. Where resetting of masonry is required, remove, clean and reset units in new mortar.

.11 After mortar has achieved initial set up, tool joints.

.12 Do not interrupt bond below or above openings.

3.9 REPAIR/RESTORATION

.1 Upon completion of masonry, fill holes and cracks, remove loose mortar and repair defective work.

3.10 CLEANING

.1 Clean in accordance with Section 01 74 11, supplemented as follows.
.1 Progress Cleaning:
.1 Standard Concrete Unit Masonry:

.1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block. Clean wall surface with suitable brush or burlap.

3.11 PROTECTION

.1 Brace and protect concrete unit masonry in accordance with Section 04 05 10.

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 Underwriter's Laboratories of Canada (ULC)
.1 CAN/ULC-S101-07, Standard Methods of for Fire Endurance Tests of Building Construction and Materials.
.2 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
.3 CAN/ULC-S115-11, Standard Method of Fire Tests of Firestop Systems.

1.2 DEFINITIONS

.1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.

.2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.

.3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.

.4 Continuity of Fire Separations: NBC 2010, Division B, Parts 3.1.8 and 3.1.9.1, 9.10.9):
.1 Wall, partition or floor assemblies required to be a fire separation shall be: constructed as a continuous element; have a fire resistance rating; have openings protected by a closure; and have penetrations sealed by a firestop.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets.

.3 Shop Drawings:
.1 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation.
.2 Construction details should accurately reflect actual job conditions.

.4 Quality assurance submittals: submit following in accordance with Section 01 45 00.
.1 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
.2 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle materials in accordance with Section 01 61 00.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
.3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.

.2 Storage and Protection:
.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Fire stopping and smoke seal systems: in accordance with CAN/ULC-S115.

.1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN/ULC-S115 and not to exceed opening sizes for which they are intended.
.2 Fire stop system rating: F.

.2 Service penetration assemblies: systems tested to CAN/ULC-S115.

.3 Service penetration fire stop components: certified by test laboratory to CAN/ULC-S115.

.4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.

.5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.

.6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.

.7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

.8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.

.9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

.10 Sealants for vertical joints: non-sagging.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PREPARATION

.1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.

.1 Ensure that substrates and surfaces are clean, dry and frost free.

.2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.

.3 Maintain insulation around pipes and ducts penetrating fire separation.

.4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 INSTALLATION

.1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.

.2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.

.3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

.4 Tool or trowel exposed surfaces to neat finish.

.5 Remove excess compound promptly as work progresses and upon completion.

3.4 SEQUENCES OF OPERATION

.1 Proceed with installation only when submittals have been reviewed by Departmental Representative.

.2 Install floor fire stopping before interior partition erections.

.3 Metal deck bonding: fire stopping to precede spray applied fireproofing to ensure required bonding.

.4 Mechanical pipe insulation: certified fire stop system component.
.1 Ensure pipe insulation installation precedes fire stopping.

3.5 FIELD QUALITY CONTROL

.1 Inspections: notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

.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.

3.6 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.7 SCHEDULE

.1 Fire stop and smoke seal at:
.1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
.2 Edge of floor slabs at curtain wall and precast concrete panels.
.3 Top of fire-resistance rated masonry and gypsum board partitions.
.4 Intersection of fire-resistance rated masonry and gypsum board partitions.
.5 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
.6 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
.7 Openings and sleeves installed for future use through fire separations.
.8 Around mechanical and electrical assemblies penetrating fire separations.
.9 Rigid ducts: greater than 129 cm2: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM International
.1 ASTM C473-10, Standard Test Methods for Physical Testing of Gypsum Panel Products.
.2 ASTM C475-02(2007)/C475M-02(2007), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
.3 ASTM C514-04(2009)e1, Standard Specification for Nails for the Application of Gypsum Board.
.4 ASTM C840-11, Standard Specification for Application and Finishing of Gypsum Board.
.5 ASTM C954-11, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
.6 ASTM C1002-07, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
.7 ASTM C1047-10a, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
.8 ASTM C1280-11, Standard Specification for Application of Gypsum Sheathing.
.9 ASTM C1396/C1396M-11, Standard Specification for Gypsum Board.
.10 ASTM D2394-05(2011), Standard Test Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring.

.2 Association of the Wall and Ceilings Industries International (AWCI)
.1 AWCI Levels of Gypsum Board Finish-97.

.3 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-51.34-M86(R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
.2 CAN/CGSB-71.25-M88, Adhesive, for Bonding Drywall to Wood Framing and Metal Studs.

.4 Underwriters' Laboratories of Canada (ULC)
.1 CAN/ULC-S102-10, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

.5 American National Standards Institute (ANSI)
.1 ANSI A118.9-1992, Test Methods and Specifications for Cementitious Backer Units.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:
.1 Store gypsum board assemblies materials level indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.
.3 Protect from weather, elements and damage from construction operations.
.4 Handle gypsum boards to prevent damage to edges, ends or surfaces.
.5 Replace defective or damaged materials with new.

1.4 AMBIENT CONDITIONS

.1 Maintain temperature 10 degrees C minimum, 21 degrees C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.

.2 Apply board and joint treatment to dry, frost free surfaces.

.3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Standard board: to ASTM C1396/C1396M, regular, 13 mm thick, 1200 mm wide x maximum practical length, ends square cut, edges square.

.2 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.

.3 Resilient drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.

.4 Steel drill screws: to ASTM C1002.

.5 Stud adhesive: to CAN/CGSB-71.25.

.6 Laminating compound: as recommended by manufacturer, asbestos-free.

.7 Sealants: in accordance with Section 07 92 00.

.8 Joint compound: to ASTM C475/C475M, asbestos-free.

.9 Joint tape: to ASTM C475/C475M.
.1 Paper tape for standard gypsum board.

2.2 FINISHES

.1 Texture finish: asbestos-free standard white texture coating and primer-sealer, recommended by gypsum board manufacturer.
.1 Primer: VOC limit 50 g/L maximum to GS-11.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 ERECTION

.1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.

.2 Do application of gypsum sheathing to ASTM C1280.

.3 Support light fixtures by providingadditional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.

.4 Install work level to tolerance of 1:1200.

.5 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, and grilles.

.6 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.

.7 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.

.8 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

.9 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.

.10 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.

.11 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.3 APPLICATION

.1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.

.2 Apply single layer gypsum board to metal furring or framing using screw fasteners . Maximum spacing of screws 300 mm on centre.
.1 Single-Layer Application:

.1 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.

.3 Apply single layer gypsum board to concrete block surfaces, where indicated, using laminating adhesive.
.1 Comply with gypsum board manufacturer's recommendations.
.2 Brace or fasten gypsum board until fastening adhesive has set.
.3 Mechanically fasten gypsum board at top and bottom of each sheet.

.4 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.

.5 Install gypsum board with face side out.

.6 Do not install damaged or damp boards.

.7 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

.1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre.

.2 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.

.3 Splice corners and intersections together and secure to each member with 3 screws.

.4 Install access doors to electrical and mechanical fixtures specified in respective sections.
.1 Rigidly secure frames to furring or framing systems.

.5 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.

.6 Gypsum Board Finish: finish gypsum board walls to following levels in accordance with AWCI Levels of Gypsum Board Finish:
.1 Levels of finish:
.1 Level 5: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; apply a thin skim coat of joint compound to entire surface; surfaces smooth and free of tool marks and ridges.

.7 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.

.8 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.

.9 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

.10 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

.11 Apply one coat of white primer sealer over surface to be textured. When dry apply textured finish in accordance with manufacturer's instructions.

.12 Mix joint compound slightly thinner than for joint taping.

.13 Apply thin coat to entire surface using trowel or drywall broad knife to fill surface texture differences, variations or tool marks.

.14 Allow skim coat to dry completely.

.15 Remove ridges by light sanding or wiping with damp cloth.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.
.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.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by gypsum board assemblies installation.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society for Testing and Materials (ASTM)
.1 ASTM E1264-08e1, Standard Classification for Acoustical Ceiling Products.
.2 ASTM E2638-10, Standard Test Method for Objective Measurement of the Speech Privacy Provided by a Closed Room.

.2 Canadian General Standards Board (CGSB)

.3 Canadian Standards Association (CSA)

.4 Underwriters Laboratories of Canada (ULC)
.1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials.

1.2 SAMPLES

.1 Submit samples in accordance with Section 01 33 00.

1.3 REGULATORY REQUIREMENTS

.1 Fire-resistance rated floor/ceiling and roof/ceiling assembly: certified by a Canadian Certification Organization accredited by Standards Council of Canada.

1.4 ENVIRONMENTAL REQUIREMENTS

.1 Permit wet work to dry before commencement of installation.

.2 Maintain uniform minimum temperature of 15°C and humidity of 20 - 40% before and during installation.

.3 Store materials in work area 48 hours prior to installation.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Acoustic units for suspended ceiling system: to CAN/CGSB-92.1.
.1 Non-directional fissures, general applicationm Type 3, form 2, Pattern CDm White, Sag resistance 16-29 degrees C / 70% RH, recycled content 25%.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Do not install acoustical panels and tiles until work above ceiling has been inspected by Departmental Representative.

3.2 INSTALLATION

.1 Install acoustical panels and tiles in ceiling suspension system.

.2 Install fibrous acoustical media over entire area above suspended metal panels.

.3 In fire rated ceiling systems, secure lay-in panels with hold-down clips and protect over light fixtures, diffusers, air return grilles and other appurtenances according to Certification Organizations design requirements.

3.3 APPLICATION

.1 Install acoustical units as per reflected ceiling plan.

.2 Scribe acoustic units to fit adjacent work. Butt joints tight, terminate edges with moulding.

3.4 INTERFACE WITH OTHER WORK

.1 Co-ordinate ceiling work to accommodate components of other sections, such as light fixtures, diffusers, speakers, sprinkler heads, to be built into acoustical ceiling components.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Architectural Painting Specifications Manual, Master Painters Institute (MPI), 2010.

.2 Systems and Specifications Manual, SSPC Painting Manual, Volume Two, Society for Protective Coatings (SSPC).

.3 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings) of the Environmental Protection Agency (EPA).

.4 National Fire Code of Canada 2010 (NFC).

1.2 QUALITY ASSURANCE

.1 Contractor shall have a minimum of five years proven satisfactory experience. When requested, provide a list of last three comparable jobs including, job name and location, specifying authority, and project manager.

.2 Qualified journeymen who have a "Tradesman Qualification Certificate of Proficiency" shall be engaged in painting work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.

.3 Conform to latest MPI requirements for interior painting work including preparation and priming.

.4 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) shall be in accordance with MPI Painting Specification Manual "Approved Product" listing and shall be from a single manufacturer for each system used.

.5 Other paint materials such as linseed oil, shellac, turpentine, etc. shall be the highest quality product of an approved manufacturer listed in MPI Painting Specification Manual and shall be compatible with other coating materials as required.

.6 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.

.7 Standard of Acceptance:
.1 Walls: No defects visible from a distance of 1000 mm at 90° to surface.
.2 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

1.3 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

.1 Provide paint products meeting MPI "Environmentally Friendly" E2 ratings based on VOC (EPA Method 24) content levels.

.2 Where indoor air quality (odour) is a problem, use only MPI listed materials having a minimum E2 rating.

1.4 INSPECTION REQUIREMENTS

.1 Interior painting and decorating work shall be inspected by a Paint Inspection Agency (inspector) acceptable to the specifying authority and local Painting Contractor's Association. Painting contractor shall notify Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.

.2 Interior surfaces requiring painting shall be inspected by Paint Inspection Agency who shall notify Departmental Representative and General Contractor in writing of defects or problems, prior to commencing painting work, or after prime coat shows defects in substrate.

.3 Where "special" painting, coating or decorating system applications (i.e. elastomeric coatings) or non-MPI listed products or systems are to be used, paint or coating manufacturer shall provide as part of this work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Departmental Representative.

1.5 SCHEDULING OF WORK

.1 Submit work schedule for various stages of painting to Departmental Representative for approval. Submit schedule minimum of 48 hours in advance of proposed operations.

.2 Obtain written authorization from Consultant for any changes in work schedule.

.3 Schedule painting operations to prevent disruption of occupants in and about the building.

1.6 SUBMITTALS

.1 Submit product data and manufacturer's installation/application instructions for each paint and coating product to be used in accordance with Section 01 33 00.

.2 Submit WHMIS MSDS.- Material Safety Data Sheets in accordance with Section 01 11 00.

.3 Upon completion, submit records of products used. List products in relation to finish system and include the following:
.1 Product name, type and use.
.2 Manufacturer's product number.
.3 Colour numbers.
.4 MPI Environmentally Friendly classification system rating.
.5 Manufacturer's Material Safety Data Sheets (MSDS).

1.7 SAMPLES

.1 Submit full range colour sample chips in accordance with Section 01 33 00. Indicate where colour availability is restricted.

.2 Submit duplicate 200 x 300 mm sample panels of each paint and special finish with specified paint or coating in colours, gloss/sheen and textures required to MPI Painting Specification Manual standards submitted on the following substrate materials:
.1 3 mm plate steel for finishes over metal surfaces.
.2 50 mm concrete block for finishes over concrete or concrete masonry surfaces.
.3 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.

.3 When approved, sample panels shall become acceptable standard of quality for appropriate on-site surface with one of each sample retained on-site.

1.8 QUALITY CONTROL

.1 When requested by Departmental Representative, prepare and paint designated surface, area, room or item (in each colour scheme) to requirements specified herein, with specified paint or coating showing selected colours, gloss/sheen, textures and workmanship to MPI Painting Specification Manual standards for review and approval. When approved, surface, area, room and/or items shall become acceptable standard of finish quality and workmanship for similar on-site work.

1.9 DELIVERY, HANDLING AND STORAGE

.1 Deliver, store and handle materials in accordance with Section 01 61 00.

.2 Labels shall clearly indicate:
.1 Manufacturer's name and address.
.2 Type of paint or coating.
.3 Compliance with applicable standard.
.4 Colour number in accordance with established colour schedule.

.3 Remove damaged, opened and rejected materials from site.

.4 Provide and maintain dry, temperature controlled, secure storage.

.5 Observe manufacturer's recommendations for storage and handling.

.6 Store materials and supplies away from heat generating devices.

.7 Store materials and equipment in a well ventilated area with temperature range 7°C to 30°C.

.8 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.9 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Consultant. After completion of operations, return areas to clean condition to approval of Departmental Representative.

.10 Remove paint materials from storage only in quantities required for same day use.

.11 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.

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

1.10 SITE REQUIREMENTS

.1 Heating, Ventilation and Lighting:
.1 Ventilate enclosed spaces.
.2 Perform no painting work unless adequate and continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above 10°C for 24 hours before, during and after paint application until paint has cured sufficiently.
.3 Where required, provide continuous ventilation for seven days after completion of application of paint.
.4 Coordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.
.5 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
.6 Perform no painting work unless a minimum lighting level of 323 Lux is provided on surfaces to be painted. Adequate lighting facilities shall be provided by General Contractor.

.2 Temperature, Humidity and Substrate Moisture Content Levels:
.1 Unless specifically pre-approved by the specifying body, Paint Inspection Agency and the applied product manufacturer, perform no painting work when:
.1 Ambient air and substrate temperatures are below 10°C.
.2 Substrate temperature is over 32°C unless paint is specifically formulated for application at high temperatures.

.3 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.
.4 The relative humidity is above 85% or when the dew point is less than 3°C variance between the air/surface temperature.
.5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

.2 Perform no painting work when the maximum moisture content of the substrate exceeds:
.1 12% for concrete and masonry (clay and concrete brick/block).
.2 12% for plaster and gypsum board.

.3 Conduct moisture tests using a properly calibrated electronic Moisture Meter, except test concrete floors for moisture using a simple "cover patch test".

.4 Test concrete, masonry and plaster surfaces for alkalinity as required.

.3 Surface and Environmental Conditions:
.1 Apply paint finish only in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
.2 Apply paint only to adequately prepared surfaces and to surfaces within moisture limits noted herein.
.3 Apply paint only when previous coat of paint is dry or adequately cured.

.4 Additional Interior Application Requirements:
.1 Apply paint finishes only when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.
.2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.

.2 Paint materials for paint systems shall be products of a single manufacturer.

.3 Only qualified products with E2 or E3 "Environmentally Friendly" rating are acceptable for use on this project.

.4 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids, shall:
.1 be water-based.
.2 be non-flammable.
.3 be manufactured without compounds which contribute to ozone depletion in the upper atmosphere.
.4 be manufactured without compounds which contribute to smog in the lower atmosphere.
.5 do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.

.5 Water-borne surface coatings must be manufactured and transported in a manner that steps of process, including disposal of waste products arising therefrom, will meet requirements of applicable governmental acts, by-laws and regulations including, for facilities located in Canada, Fisheries Act and Canadian Environmental Protection Act (CEPA).

.6 Water-borne surface coatings must not be formulated or manufactured with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavelant chromium or their compounds.

.7 Water-borne surface coatings and recycled water-borne surface coatings must have a flash point of 61.0°C or greater.

.8 Both water-borne surface coatings and recycled water-borne surface coatings must be made by a process that does not release:
.1 Matter in undiluted production plant effluent generating a 'Biochemical Oxygen Demand' (BOD) in excess of 1] mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.

.2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to a natural watercourse or a sewage treatment facility lacking secondary treatment.

.9 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes must meet a minimum "Environmentally Friendly" E2 rating.

.10 The following must be performed on each batch of consolidated post-consumer material before surface coating is reformulated and canned. These tests must be performed at a laboratory or facility which has been accredited by the Standards Council of Canada.
.1 Lead, cadmium and chromium are to be determined using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectroscopy) technique no. 6010 as defined in EPA SW-846.
.2 Mercury is to be determined by Cold Vapour Atomic Absorption Spectroscopy using Technique no. 7471 as defined in EPA SW-846.
.3 Organochlorines and PCBs are to be determined by Gas Chromatography using Technique no. 8081 as defined in EPA SW-846.

2.2 COLOURS

.1 Submit proposed Colour Schedule to Departmental Representative for approval.

.2 Colour schedule will be based upon the selection of five base colours and three accent colours. No more than eight colours will be selected for the entire project and no more than three colours will be selected in each area.

.3 Selection of colours will be from manufacturers full range of colours.

.4 Where specific products are available in a restricted range of colours, selection will be based on the limited range.

.5 Second coat in a three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

.1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is allowed only with Departmental Representative's written permission.

.2 Paste, powder or catalyzed paint mixes shall be mixed in strict accordance with manufacturer's written instructions.

.3 Where thinner is used, addition shall not exceed paint manufacturer's recommendations. Do not use kerosene or any such organic solvents to thin water-based paints.

.4 Thin paint for spraying according in strict accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Departmental Representative.

.5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

.1 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following values:

.2 Gloss level ratings of painted surfaces shall be as specified herein.

PART 3 - EXECUTION

3.2 EXISTING CONDITIONS

.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Departmental Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.

.2 Conduct moisture testing of surfaces to be painted using a properly calibrated electronic moisture meter, except test concrete floors for moisture using a simple "cover patch test" and report findings to Departmental Representative. Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

.3 Maximum moisture content as follows:
.1 Stucco, Plaster and Gypsum Board: 12%.
.2 Concrete: 12%.
.3 Clay and Concrete Block/Brick: 12%.

3.3 PROTECTION

.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Departmental Representative.

.2 Protect items that are permanently attached such as Fire Labels on doors and frames.

.3 Protect factory finished products and equipment.

.4 Protect building occupants in and about the building.

.5 Removal of electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings shall be done prior to undertaking any painting operations by General Contractor. Items shall be securely stored and re-installed after painting is completed by General Contractor.

.6 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

.7 As painting operations progress, place "WET PAINT" signs in occupied areas to approval of Departmental Representative.

3.4 CLEANING AND PREPARATION

.1 Clean and prepare surfaces in accordance with MPI Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
.1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
.2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
.3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

.4 Allow surfaces to drain completely and allow to dry thoroughly.
.5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
.6 Use trigger operated spray nozzles for water hoses.
.7 Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or any such organic solvents to clean up water-based paints.

.2 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.3 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

.4 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes, blowing with clean dry compressed air, or vacuum cleaning.

.5 Touch up of shop primers with primer as specified in applicable section. Major touch-up including cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas, shall be by supplier of fabricated material.

.6 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.

3.5 APPLICATION

.1 Apply paint by brush or roller. Conform to manufacturer's application instructions unless specified otherwise.

.2 Brush and Roller Application:
.1 Apply paint in a uniform layer using brush and/or roller of types suitable for application.

.2 Work paint into cracks, crevices and corners.
.3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
.4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces shall be free of roller tracking and heavy stipple unless approved by Departmental Representative.
.5 Remove runs, sags and brush marks from finished work and repaint.

.3 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access and only when specifically authorized by Engineer.

.4 Apply coats of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.6 Sand and dust between coats to remove visible defects.

.7 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.

.8 Finish inside of cupboards and cabinets as specified for outside surfaces.

.9 Finish closets and alcoves as specified for adjoining rooms.

.10 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 MECHANICAL/ ELECTRICAL EQUIPMENT

.1 Unless otherwise specified, paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as noted otherwise.

.2 Boiler room, mechanical and electrical rooms: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.

.3 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.

.4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.

.5 Do not paint over nameplates.

.6 Keep sprinkler heads free of paint.

.7 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.

.8 Paint fire protection piping red.

.9 Paint disconnect switches for fire alarm system and exit light systems in red enamel.

.10 Paint natural gas piping yellow.

.11 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.

.12 Do not paint interior transformers and substation equipment.

3.7 FIELD QUALITY CONTROL

.1 Field inspection of painting operations to be carried out be independent inspection firm as designated by Departmental Representative.

.2 Advise Departmental Representative when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

.3 Co-operate with inspection firm and provide access to areas of work.

3.8 RESTORATION

.1 Clean and re-install all hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

.4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.

.5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.186-1996, High Performance Glazed Coating System, Interior.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.3 South Coast Air Quality Management District (SCAQMD), California State
.1 SCAQMD Rule 1113-04, Architectural Coatings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures

.3 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.
.1 Submit WHMIS MSDS - Material Safety Data Sheets. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for high build glazed coatings. Indicate VOC content.

.4 Provide samples in accordance with Section 01 33 00 - Submittal Procedures.
.1 Submit duplicate 400 x 200mm samples of each colour and finish coating applied to smooth hardboard.

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
.1 Deliver and store materials in manner to prevent damage.
.2 Ensure materials remain in original wrapping and containers until used.

1.4 SITE CONDITIONS

.1 Safety:
.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of materials.
.2 Ensure no open flame heating devices are used.
.3 Discourage occupancy of treated space until volatile materials are no longer being emitted and there is no odour.
.4 Provide adequate respiratory protection to exposed individuals.

.2 Ventilation:
.1 Provide ventilation continuously during and after coating application. Run system 24 hours per day during application; provide continuous ventilation for 7days after completion of application.

.3 Temperature:
.1 Do not apply emulsion systems unless uniform minimum 10 degrees C air temperature at installation area for 24 hours prior to and after application.
.2 Maintain minimum temperature 10 degrees C within area of installation until final acceptance of building.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Interior high build glazed coating materials: to CAN/CGSB-1.186 in colour selected by Departmental Representative.

.2 Primer: Provide primer suitable to bond material to substrate as recommended by manufacturer.

.3 Aggregate: Brightly coloured, quart broadcast

.4 Undercoat: a three component, undercoat consisting of a polyaspartic urethane resin, aliphatic isocyanate and filler.

.5 Flakes: Brightly coloured flakes.

.6 Sealer: a two component, UV resistant, aliphatic polyaspartic urethane sealer.

.7 Cove Base: provide cove base a minimum of 100mm up wall for an integral seal.

2.2 MIXES

.1 Mix coatings according to manufacturer's instructions.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PREPARATION

.1 Prepare surfaces in accordance with CAN/CGSB-1.186 and coating material manufacturer's instructions.

.2 Mask surrounding surfaces to provide neat, clean juncture lines.

.3 Protect adjacent surfaces and equipment from damage by overspray.

3.3 APPLICATION

.1 Apply coating to produce smooth surface, uniform in sheen, colour and finish, free from marks, dirt, particles, runs, crawls, curling, holes, air pockets and other defects and to achieve smoothness index in accordance with CAN/CGSB-1.186.

.2 Apply filler coats to porous surfaces.

.3 Apply base by brush or spray coat in two coats.

.4 Apply intermediate coat to provide decorative effect.

.5 Apply top glaze coat.

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:
.1 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.

3.5 CLEANING

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

.1 Clean surfaces to coating manufacturer's printed instructions.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Service Core and Bench Frame.

.2 Leg Frame.

.3 Cabinet Support Rails.

.4 Service Cover Rails and Panels.

.5 Closure Panels.

.6 Island Verticle Post Structure.

.7 Wall Verticle Post Structure.

.8 Service Drops.

1.2 RELATED SECTION

.1 Section 12 36 00 - Countertops

.2 Section 12 35 53.13 - Manufactured Metal Casework

.3 Section 22 40 00 - Plumbing Fixtures

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

1.3 REFERENCES

.1 American National Standards Institute (ANSI)
.1 ANSI A208.1-2009, Particleboard.
.2 ASTM A167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
.2ASTM A240/A240M-11b, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
.3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.4 ASTM B117-11, Standard Practice for Operating Salt Spray (Fog) Apparatus. .5ASTM B456-11e1, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.

.5 ASTM E54-80(1996), Standard Test Methods for Chemical Analysis of Special Brasses and Bronzes. .7 ASTM E478-08, Standard Test Methods for Chemical Analysis of Copper Alloys. .1 CSA O112.10-0, Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure). Association of Canada (EEMAC) (NEMA)
.6 NEMA LD 3-2005, High-Pressure Decorative Laminates (HPDL).

1.4 SUBMITTALS

Refer to Section 01 33 00 - Submittal Procedures, for requirements, procedures, etc

.1 Product Data: Drawings shall include data and details for construction of the laboratory furniture as well as information regarding the name, quantity, type and construction of materials (such as hardware, gauges, etc), that will be used to complete the project.

.2 Shop Drawings:
.1 Furnish shop drawings illustrating the layout and placement of all laboratory furniture, casework and fume hoods as well as any products included in this section.
.2 Indicate the type and location of all service fittings and associated supply connections.
.3 Peparation instructions and recommendations.
.4 Storage and handling requirements and recommendations.
.5 Installation methods.

.3 Selection Samples Submit the following:
.1 Three complete sets of color chips representing the manufacturer's full range of available colors. Minimum sample size 2 inches by 3 inches(50mm x 76mm).

.4 Quality Assurance
.1 Design Data/Test Reports: Submit test data and design criteria which are in compliance with the project specifications.
.2 Certificates: All certifications required in the specifications shall be submitted with the oringal submittal package under separate cover. Certicicates must be provided with the signature of a qualifed individual of the supplier.

.3 Manufacturers' Instructions: Provide manufacturer's instructions for installation and maintenance of all products provided and installed within this section. Instructions will be in bound form, tabbed and organized by section number.

1.5 QUALITY ASSURANCE

.1 Manufacturers Qualifications: The following list of information will be provide to the Department Representative at least ten (10) days prior to the bid opening:
.1 List of manufacturing facilities;
.2 A list of ten (10) installations of comparable stature completed within the past 5 years;
.3 Construction details depicting the materials, sizes and methods of construction:
.4 Independent laboratory test reports that include information on cabinet, fume hood and table top finish and performance that have been conducted within the last two years.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packaging, Shipping, Handling and Unloading:
.1 Packaging: Products shall have packaging adequate enough to protect finished surfaces from soiling or damage during shipping, delivery and installation.
.2 Delivery: Casework delivery shall only take place after painting, utility roughins and related activities are completed that could otherwise damage, soil or deteriorate casework in installation areas.
.3 Handling: Care, such as the use of proper moving equipment, experienced movers, etc., shall be used at all times to avoid damaging the casework. Until installation takes place, any wrapping, insulation or other method of protection applied to products from the factory will be left in place to avoid accidental damage.

.2 Acceptance at Site: Casework will not be delivered or installed until the conditions specified under Part 3, Installation section of this document have been met.

.3 Storage: Casework shall be stored in the area of installation. If, prior to installation, it is necessary for casework to be temporarily stored in an area other than the installation area, the environmental conditions shall meet the environmental requirements specified under the Project Site Conditions article of this section.

1.7 PROJECT SITE CONDITIONS

.1 An operational HVAC system that maintains temperature and humidity at occupancy levels must be in place;

.2 Adjacent and related work shall be complete;

.3 Ceiling, overhead ductwork and lighting must be installed;

.4 Site must be free of any further construction such as "wet work";

.5 Required backing and reinforcements must be installed accurately and the project must be ready for casework installation.

1.8 WARRANTY

.1 Furnish a written warranty that Work performed under this Section shall remain free from defects as to materials and workmanship for a period of two (2) years from date of shipment. Defects in materials and workmanship that may develop within this time are to be replaced without cost or expense to the Owner. Defects include but are not limited to:
.1 Ruptured, cracked, or stained coating
.2 Discoloration or lack of finsih integrity
.3 Cracking or peeling of finish
.4 Slippage, shift, or failure of attachment to wall, floor, or ceiling
.5 Weld or structural failure
.6 Warping or unloaded deflections of components
.7 Failure of hardware

.2 The warranty with respect to products of another manufacturer sold by Mott Manufacturing is limited to the warranty extended by that manufacturer to Mott Manufacturing.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Sheet Steel: Mild steel, cold rolled furniture grade to requirements of ASTM A1008/A1008M, Grade C or higher, with smooth surfaces to furniture quality.

.2 Galvanized Sheet Steel: quality galvanised sheet steel to ASTM 653, Designation Z275.

.3 Stainless Steel:
.1 Sheet: ASTM A240, Type 304 AND 316 alloy.
.2 Finish: Unless otherwise indicated, AISI No. 4 Brushed finish.

.4 Glass: conforming to CAN2 12.3M76, Glazing Quality. Laminated Glass: CAN/CGSB12.1M90, Type 1 with clear PVB interlayer. Total nominal thickness of laminated glass: 6 mm.

2.2 DESIGN REQUIREMENTS

.1 Support systems shall be a core and panel style support structure

.2 Core structure can be supported by anchoring to suitable flooring material or may be supported by structural end gables (outrigger legs).

.3 Modular components shall be suitable for single faced wall cores or double faced peninsula or island configuration.

.4 Core assemblies shall have removable panels on all sides.

2.3 CONSTRUCTION

.1 Suspended Base/Wall Cabinets:
.1 Design and construction shall be as in section 12 35 53 Laboratory Metal Casework .
.2 spended Cabinets shall be supported using hook shaped rails attached near the front and rear of the cabinets. It shall be possible to remove and relocate a fully loaded cabinet to any position between legs
.3 Suspended wall cases: Provide a system of coldrolled steel hanger rails attached to the casework frames, to be vertically adjustable on one inch increments. Installation and removal to be accomplished without the use of tools

.2 Service Core and Bench Frame:

.1 Materials and Thicknesses: Use following minimum U.S. standard steel thicknesses for furniture manufacturing:

a) 11 Ga "U" brackets, box brackets

b) 14 Ga Front cabinet support rails, rear cabinet support rails

c) 16 Ga Vertical service core post, vertical island and wall posts, fixed bench frames, adjustable bench frames

d) 18 Ga Upper service cover panels, lower service cover panels, end close off panels, service drops, adjustable service cover support rail, service cover support rails

.2 The bench frame system shall provide complete independent rigid support for work surfaces, under counter suspended cabinets, over head shelving. Service cover panels, sinks and all mechanical and electrical line work as necessary to make the assembly operation.

.3 The framing system shall accommodate the following design concepts: Separate service strip consisting of a flat counter top 24" deep with a 6" deep service strip top with integral 6" high back splash.

.4 The system shall allow the addition, relocation or removal of suspended base cabinets, the removal of the entire leg frame module including base cabinets and work surfaces, leaving intact the separate service strip with all its service fittings, service lines and cover panels as a finished operational component.

.5 The Standard Bench module shall be based on a standard 60" nominal inside dimension to accommodate any combination of cabinets up to 60" in width. It shall be possible to make 24", 36", 48" or custom length modules where necessary to suit room dimensions.

.3 Leg Frames:

.1 bench leg frame shall be fabricated from dieformed components. All welds are to be ground smooth ready for painting. Each leg frame shall have a 3/8 diameter levelling bolt, a slip on wrap around black PVC shoe and two welded studs for securing to service strip.

.2 adjustable height leg frames shall be constructed as specified in 2.4.C.1. with the following additions. The front leg shall be constructed of two telescoping frames on 1/2" centres with a total height adjustment of 6" telescoping frames are to be locked in position with a spring loaded pin. Accessible from underside of the leg frame.

.4 Cabinet Support Front Rail:
.1 Front cabinet support rail shall be fabricated in a channel formation to be secured to the adjacent leg frames. The bottom edge of the rail shall be designed to engage with the front rail of the suspended base cabinet. The outer rail shall fit flush with the face of the cabinet. Flat ledges above the cabinet that will collect dust are not acceptable

.5 Cabinet Support Rear Rail:
.1 Rear cabinet support rail shall be fabricated in a channel formation to over lapped the adjacent leg frames. The bottom edge of the rail shall be designed to engage with the front rail of the suspended base cabinet.

.6 Service Cover Support Rails:
.1 Service cover support rail shall be fabricated in a "Z" channel formation to be secured to the service strip. The bottom edge of the rail shall be designed to suspend the top edge of the service cover panel.

.7 Service Cover Panels:
.1 Rear cabinet support rail shall be provided between all leg frames to totally enclose the service strip space. Service Cover Panels shall be constructed in two sections. The lower section shall be fixed in place to the rear of the service strip. The upper section shall be easily removable, with out the use of tools. Each panel shall be formed to fit between each leg frame and to be supported in place by the service cover support rail.

.8 End Closure Panels:
.1 End closure panels shall be used to close off the ends of the service strip. End closure panels for wall benches shall be flanged on one edge, the other unformed edge shall slide in to a slip joint angle secured to the wall. Island assemblies shall have both edges flanged for securing to the service strip.

.9 Island Verticle Post Structure:
.1 Provide a twopiece telescoping upper vertical slotted post 15/8" by 15/8" sleeved into a 17/8" by 17/8" lower post. Upper and lower section shall be through bolted with 3/8" diameter zinc plated bolts to allow for field levelling.
.2 The vertical post system shall be attached with an upper horizontal "u" bracket, lateral "u" strut, 3/8" zinc plated bolts and spring nut. The lower horizontal box bracket shall be lagged to the floor, and attached to the furniture system with 3/8" zinc plated bolts nd spring nuts.
.3 The vertical post system shall be slotted on 1" centres to except a notched shelf bracket. Shelves shall be fully adjustable without the use of tools.
.4 The shelf bracket shall be notched to fit in to the slotted post, and positively lock when weight is applied. The bottom shall be flanged to support the horizontal shelf, and will be tabbed and pre punched to mount the shelf.
.5 Shelves shall be of high pressure plastic laminate, painted steel, epoxy or similar material to support the desired weight. The rear of the shelf shall be blocked off with a painted steel angle running the open width of the shelf.

.10 Wall Verticle Post Structure:
.1 Provide a one piece vertical slotted post 1 5/8" by 13/16" by 36" or 48" as required.
.2 The vertical post system shall be through secured to the wall material with appropriate fasteners to suit wall conditions.
.3 The vertical post system shall be same as above.
.4 The shelf bracket shall be the same as above.
.5 Shelves shall be the same as above.

.11 Service Drop Structure:
.1 Metal Finish to be Laboratory Steel Furniture Finish.

PART 3 - EXECUTION

3.1 INSTALLERS

.1 Installer Qualifications:

.1 Installer shall have a minimum of 5 years continued experience in installation or application of systems similar to those required for this project.
.2 Installer shall be authorized by either the distributor or manufacturer. Warranty will be void if unauthorized installer executes the installation.

3.2 EXAMINATION

.1 Site Verification of Conditions:
.1 Building must be enclosed (windows and doors sealed and weathertight);
.2 An operational HVAC system that maintains temperature and humidity at occupancy levels must be in place;
.3 Ceiling, overhead ductwork and lighting must be installed;
.4 Site must be free of any further construction such as "wet work."
.5 Required backing and reniforcements must be intalled accurately and the project must be ready for casework installation.

.2 NOTE: In the event that any of the specified requirements for installation are not present at the time of requested delivery, the general contractor or owner must provide the casework manufacturer with a letter of deviation that releases the manufacturer from any responsibility or liability from an damage to the products resulting from the unfavorable building conditions.

3.3 INSTALLATION

.1 Casework Installation:
.1 Casework shall be set with components plumb, straight and square, securely anchored to building structure with no distortion. Concealed shims shall be used as required.
.2 Cabinets in continuous runs shall be fastened together with joints flush, uniform and tight with misalignment of adjacent units not to exceed 1/16 of an inch.
.3 Wall casework shall be secured to solid material, not lath, plastic or gypsum board
.4 Top edge surfaces shall be abutted in one true plane. Joints are to be flush and gap shall not exceed 1/8 of an inch between tops units.
.5 Casework and hardware shall be adjusted and aligned to allow for accurate connection of contact points and efficient operation of doors and drawers without any warping or binding.

.2 Countertop Istallation:
.1 Countertops are to have been fabricated in lengths according to drawings, with ends abutting tightly and sealed with corrosion resistant sealant.
.2 Tops will be anchored to base casework in a single true plane with ends abutting at hairline joints with no raised edges at joints.
.3 Joints shall be factory prepared having no need for infield processing of top and edge surfaces.
.4 Joints shall be dressed smoothly, surface scratches removed and entire surface cleaned thoroughly.

3.4 CLEANING

.1 Ensure all products are unsoiled and match factory finish. Remove or repair damaged or defective units.

.2 Clean all finished surfaces, including drawers and cabinet shelves, and touch up as necessary.

.3 Countertops shall be cleaned and free of grease or streaks.

3.5 PROTECTION

.1 Counter tops and ledges shall be protected with 1/4 inch ribbed cardboard for the remainder of the construction process.

.2 Examine casework for damaged or soiled areas; replace, repair, and touchup as required.

.3 Touchup, repair or replace damaged products before Substantial Completion.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Modular Casework

.2 Stainless Steel Casework

.3 Shelving

.4 Electrical Fixtures

1.2 RELATED SECTIONS

.1 Section 12 31 00 -Manufactured Metal Casework

.2 Section 12 36 00 - Countertops

.3 Section 22 44 00 - Plumbing Fixtures

.4 Related Work to be performed by others:
.1 Final insppection of all plumbing, service and electrical fixtures attached to casework or countertop (excluding piping and wiring within fume hoods).
.2 Final connection to service lines of all plumbing, service and electrical fixtures attached to laboratory casework or furniture."

1.3 REFERENCES

.1 American National Standards Institute (ANSI)
.1 ANSI A208.1-2009, Particleboard.

.2 ASTM International (ASTM)
.1 ASTM A167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
.2 ASTM A240/A240M-11b, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
.3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.4 ASTM B117-11, Standard Practice for Operating Salt Spray (Fog) Apparatus.
.5 ASTM B456-11e1, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
.6 ASTM E54-80(1996), Standard Test Methods for Chemical Analysis of Special Brasses and Bronzes.
.7 ASTM E478-08, Standard Test Methods for Chemical Analysis of Copper Alloys.

.3 CSA International (CSA)
.1 CSA O112.10-0, Evaluation of Adhesives for Structural Wood Products (Limited Moisture Exposure).

.4 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.5 National Electrical Manufacturers Association (NEMA)
.1 NEMA LD 3-2005, High-Pressure Decorative Laminates (HPDL).

1.4 SUBMITTALS

.1 Refer to Section 01 33 00, :Submittal Procedures", for requirements, procedures, etc.

.2 Products Data: Drawings shall include data and details for construction of the laboratory casework as well as information regarding the name, quantity, type and construction of materials (such as hardware, gauges, etc), that will be used to complete the project.

.3 Shop Drawings:
.1 furnish shop drawings illustrating the layout and placement of all laboratory casework and fume hoods as well as any products included in this section.
.2 Indicate the type and location of all service fittings and associated supply connections.
.3 Preparation instructions and recommendations.
.4 Storage and handling requirements and recommendations.
.5 Installation methods.

.4 Selection Samples, Submit the following:
.1 Two complete set of color chips representing the manufacturer's full range of available colors. Minimum sample size 2 inches by 3 inches (50mm x 76mm).
.2 Two Countertop backsplash and finished edge samples.

.5 Quality Assurance/Control
.1 Design Data/Test Reports: Manufacturer shall submit test data and design criteria which are in compliance with the project specifications.

.2 Certificates: All certifications required in the specifications shall be submitted with the original submittal package under separate cover. Certificates must be provided with the signature of a qualified individual of the supplier.
.3 Manufacturers' Instructions: Provide manufacturer's instructions for installation and maintenance of all products provided and installed within this section. Instructions will be in bound form, tabbed and organized by section number.

1.5 QUALITY ASSURANCE

.1 Manufacturer Qualififcations .1 following list of information will be provide to the Architect at least ten (10) days prior to the bid opening:
.1 List of manufacturing facilities;
.2 A list of ten (10) installations of comparable stature completed within the past 5 years;
.3 Construction details depicting the materials, sizes and methods of construction;
.4 Independent laboratory test reports that include information on cabinet, fume hood and table top finish and performance that have been conducted within the last two years.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packaging, Shipping, Handling and Unloading
.1 Packaging: Products shall have packaging adequate enough to protect finished surfaces from soiling or damage during shipping, delivery and installation.
.2 Delivery: Casework delivery shall only take place after painting, utility roughins and related activities are completed that could otherwise damage, soil or deteriorate casework in installation areas.
.3 Handling: Care, such as the use of proper moving equipment, experienced movers, etc., shall be used at all times to avoid damaging the casework. Until installation takes place, any wrapping, insulation or other method of protection applied to products from the factory will be left in place to avoid accidental damage.

.2 Acceptance at Site:
.1 Casework will not be delivered or installed until the conditions specified under Part 3, Installation section of this document have been met.

.3 Storage:
.1 Casework shall be stored in the area of installation. If, prior to installation, it is necessary for casework to be temporarily stored in an area other than the installation area, the environmental conditions shall meet the environmental requirements specified under the Project Site Conditions article of this section.

1.7 PROJECT SITE CONDITIONS

.1 Building must be enclosed (windows and doors sealed weathertight);

.2 An operational HVAC system that maintains temperature and humidity at occupancy levels must be in place;

.3 Adjacent and related work shall be complete;

.4 Ceiling, overhead ductwork and lighting must be installed;

.5 Site must be free of any further construction such as "wet work";

.6 Required backing and reinforcements must be installed accurately and the project must be ready for casework installation.

1.8 WARRANTY

.1 Furnish a written warranty that Work performed under this Section shall remain free from defects as to materials and workmanship for a period of two (2) years from date of installation. Defects in materials and workmanship that may develop within this time are to be replaced without cost or expense to the Owner. Defects included by are not limited to:
.1 Ruptered, cracked, or stained coating
.2 Discoloration or lack of finish integrity
.3 Cracking or peeling of finish
.4 Slippage, shift, or failure of attachment to wall, floor, or ceiling
.5 Weld or structural failure
.6 Warping or unloaded deflection of components
.7 Failure of hardware

.2 The warranty with respect to products of another manufacturer sold by Mott Manufacturing is limited to the warranty extended by that manufacturer to Mott Manufacturing.

PART 2 - PRODUCTS

2.1 CASEWORK MATERIALS

.1 Stainless Steel
.1 Sheet: ASTM A240, Type 304 or 316 alloy.
.2 Finish: Unless otherwise indicated, AISI No. 4 Brushed Finish

.2 Galvanized Sheet Steel:
.1 Commercial quality galvanized sheet steel to ASTM 653, Designation Z275.

.3 Glass:
.1 Clear Float, 6mm and 3mm thick, conforming to CAN2 12.3M76, Glazing Quality. Laminated Glass: CAN/CGSB12.1M90, Type 1 with clear PVB interlayer. Total nominal thickness of laminated glass: 6 mm.

.4 Sealant:
.1 One component, RTV silicone sealant. Color to suit application.

.5 Resiliant Base and Adhesive:
.1 Top set coved, 3mm (1/8") thick, 150mm (6") high and 100mm (4") high as indicated for base units, including premolded stops and external corners or color selected by Department representative from full range. Continuous lengths. Adhesive for rubber base shall be trowelled on giving 100% coverage. Use an adhesive compatible with both surfaces, as recommended by the base manufacturer.

2.2 CASEWORK CONSTRUCTION

.1 Materials and Thickness: Use the following minimum steel thickness for furniture manufacturing:
.1 3mm (11 Ga) leveling bolt gusset plates.
.2 1.9mm (14 Ga) drawer slides and side suspension channels.
.3 1.5mm (16 Ga) for tubular rails, legs for tables, gusset plates, cabinet top and intermediate horizontal rails.
.4 1.2mm (18 Ga) for door and drawer fronts, cabinet floor, cabinet sides, vertical front members, cabinet toe kick, service cover panels, table and kneehole frames, front rails, gable legs and dust caps, false panels, furring and filler panels.
.5 0.9mm (20 Ga) for drawer backs, door backs, vertical closure channel, removable back panels, shelves, drawer bodies, drawer dividers, bin bodies, and pullout shelves.

.2 Cabinet Frame:

.1 Provide onepiece dieformed cabinet bottom construction with return side flanges turned down. Spot weld flanges to cabinet sides.

.2 Cabinet bottoms shall be turned down at front to form 32mm (11/4") "U" channel to accept toe kick and turn down 133mm (51/4") at back with 16mm (5/8") return to form the back lower member of cabinet base. Provide punched 19mm (3/4") dia. corner holes for access to levelers and to accept PVC press plugs. It shall be possible to access levelers from above cabinet without removing drawers or drawer supports.

.3 Provide additional vertical 75mm (3") "HAT" shaped channels, spotwelded to or formed with the rear vertical corner. Channel shall be provided with prepunched holes to receive shelf clips, and slotted holes to receive drawer suspension tracks. Cabinets 762mm (30") wide and larger shall be provided with intermediate 117mm (45/8") "HAT" channels to brace cabinet and accept shelf clips and drawer tracks

.4 Where applicable, the front corner posts shall be prepunched and slotted to accept drawer suspension systems and suspension pullout shelves. Front vertical posts shall form inboard flush front construction for doors and drawers acting as the cabinet main member side gable tying the cabinet bottom and horizontal member together to form a rigid case. Front post rear closure channels shall be "J" shaped 9mm (11/32") x 33mm (15/16") x 49mm (115/16"). Provide channel with prepunched holes to receive shelf clips.

.5 Doors and drawers shall overlay top intermediates and floor horizontal members.

.6 Top horizontal front framing member shall form a "J" shaped section 75mm (3") wide, 10mm (3/8") return by 25mm (1") deep with 16mm (5/8") return.

.7 Intermediate horizontal framing members shall form a "U" 32mm (11/4") high with a 25mm (1") return on top and 16mm (5/8") return on bottom.

.8 Top rear horizontal framing member shall be 50mm (2") x 32mm (11/4") angle section welded to back corner lapped post and side gables with welded corner gusset plates acting as cabinet bracing and counter top material fixing member.

.9 Enclose cabinetry toe space shall be 75mm (3") deep x 100mm (4") high and shall act as a total enclosure to bottom of cabinet. Toe space section shall key up into "U" shaped front floor member and act as reinforcement. Toe space, front floor of cabinet and corner post sections shall be spot welded together forming one structural member.
.10 The toe space members, side gable returns, and back lower member shall form all welded structural corner to accept leveller gussets and 10mm (3/8") levelling bolts.
.11 Cabinet construction shall be electro spotwelded to form a strong wellfitted, onepiece unit.
.12 Exposed horizontal structural cabinet members between doors and drawers shall be unacceptable.

.3 Cabinet Hardware:
.1 Pulls: Provide handles for drawers and hinged doors in 100mm (4") stainless steel.
.2 Door Hinges: Provide five knuckletype barrel door hinges of 1.9mm (14 Ga) steel screwed into door and fastened to cabinet side stile with two counter sunk #832 zinc plated machine screws & captive serrated tooth washer nuts. Hinge finish shall be stainless steel.

.4 Base Cabinet Components:
.1 Provide removable back panels for cupboard base cabinets. Provide partial back panels 229mm (9") in height to accommodate plumbing at sink units. When requested, provide back panels and security panels on cabinets requiring locks.
.2 Shelving edges; turned down on all four sides 25mm (1"), and returned under on front and back 25mm (1"). Shelves 914mm (36") and longer shall be provided with "HAT' channel reinforcement at front edge.
.3 Doors:
.1 Fabricate doors of 2 telescoping metal panels, 19mm (3/4") thick, with a sounddeadening material extending continuously fullwidth, and top to bottom. Reinforce hinged side of door adequately with hinge machine screws to prevent sagging. Secure recessed hinges to cabinet posts with machine screws and concealed selflocking nuts. Provide nylon roller friction catches, mounted on horizontal top or intermediate members pull side of doors. Provide each hinged door with 2 rubber bumpers.

.2 Doors, drawers, tracks and back panels shall be replaceable in the field without requiring special tools.

.3 All standard double door cabinets shall be designed without center stiles to maximize access to the cabinet.

.4 Drawers:

.1 Fabricate drawer fronts of 2 telescoping metal panels and totally filled with sounddeadening material to eliminate possible drumming effect. Form removable outside panel with lip to fit over inside panel on top edge, and to lock into position at bottom with rivets to form a rigid, onepiece 19mm (3/4") thick drawer front.

.2 Provide drawer operation on Full Extension Drawer Slides, 508mm (20") extension, load capacity 45kg (100 pounds).: Equal to: Knape & Vogt #8400B.

.3 Drawer body shall consist of one piece stainless steel construction including the bottom, two sides, back and inner front flanged end which shall be welded to the interior drawer front head. The exterior drawer front shall have a channel formation on the top edge with ground smooth and fully finished return edges telescoping together to form fully soundeddeadened drawer front. Drawer bodies shall have a reinforcing bend on top edges.

.4 Provide builtin stops to prevent inadvertent removal of drawers, with allowance for drawer to be removed by lifting front of drawers and pulling out.

.5 Provide drawer pulls in central location of drawer face. Two handles shall be provided on units 762mm (30") and larger.

.5 Leg Sets:

.1 Leg sets shall consist of two 50mm (2") square metal tubular legs complete with steel bolt levellers and slip on PVC shoes.

.2 Legs, when secured together, shall be provided with 25mm (1") x 50mm (2") steel rail centred 203mm (8") up from bottom of leg.

.3 Top of legs, both standing and sitting heights, shall have a 1.9mm (14 Ga) triangular mounting plate welded in position for securing to underside of countertop.

.6 Apron Drawer Assembly:

.1 Apron drawer assembly shall be fabricated from metal channel shaped skirting panels of modular widths the same as standard base cabinets. Rails 95mm (33/4") high channel ends shall be turned to fit into end mounting brackets. Drawer suspension framing shall be mechanically fixed to channels, welded integrally with front and back channel sections formed into a rigid onepiece frame.
.2 Where called for, drawers located in table aprons shall be supplied in a maximum width of 381mm (15") with two drawers supplied in tables 1219mm (48") and wider. Drawer suspension shall be with 25mm (1") nylon ball bearing rollers and selfclosing action, custom manufactured 1.5mm (16 Ga) suspension system.

.7 Front Rails:
.1 Front rail units shall be fabricated from a single metal channelshaped skirting panel in modular widths the same as standard base cabinets. Channel ends shall be turned to fit into end mounting brackets. Rails are 95mm (33/4") high.

.8 Gable Legs:
.1 Gable legs shall consist of two telescoping side panels totally enclosed on all four sides and welded to form a strong rigid unit.
.2 Gables shall be 38mm (11/2") thick with 75mm x 100mm (3" x 4") toe space and designed to be secured in a concealed fashion to the adjacent kneehole assembly or to the bench top material.
.3 Gable legs shall be provided with two levelling devices.

.9 Bin Cabinets:
.1 Constructed the same as a standard base cabinet, except the door panels shall be hinged at the bottom to permit the door to tilt out from the top. Bin section shall have its own builtin catch, designed to stop and hold the loaded bin at a predetermined opened position.
.2 Bin door shall have one integral bin compartment capable of supporting 45kg (100 pounds) without sagging or binding.
.3 Bin cabinets shall be suitably fastened in place only in fixed bench assemblies to prevent any tipping action when bin sections are loaded and in an open position.

.4 When shown on drawings, removable leakproof bin liners with two lift out handles shall be designed to fit into bin compartment and fabricated of either Type 304, 1.2mm (18 Ga) stainless steel.

.10 Control Panel Base Cabinets 457mm (18") or 559mm (22") optional depths:

.1 Constructed the same as standard base cabinets, except blank panels are provided above cupboard doors for the mounting of remote control fittings. Cabinet shall be complete with removable back panels.

.11 File Drawer Cabinets:

.1 Construct file drawer cabinets in similar manner to standard base cabinets, and consisting of 1 or 2 double height file drawers for low height or standard height file cases.

.2 Provide each file drawer complete with 2 file supports and hanger rods.

.3 The file drawer shall be provided with 508mm (20") full extension telescoping drawer tracks.

.4 Hanger rods are adjustable to accommodate legal or letter size files.

.12 Service Cover Panels:

.1 Service cover panels shall be provided, where called for, between base cabinets to enclose the pipe space. Service cover panels shall be designed in two sections. The lower section shall be fixed in place to mount cove base moulding. The upper section shall be fitted between the base cabinets and shall be removable.

.13 Filler Panels:

.1 Fabricate front filler panels complete with flanges on both sides and a 75mm x 100mm (3" x 4") toe space along the working face.

.2 Scribe filler panels shall be flanged on one side and flat on the other, to be cut on jobsite to suit wall conditions, and shall fit into double angles secured to the wall. No visible mounting screws permitted.

.3 Corner filler panels shall be a twopiece construction, one fixed panel and the other a variable panel to facilitate room dimensions. Each shall have flanges and an integral 75mm x 100mm (3" x 4") toe space filler to interlock with its counterpart.

.4 End closing filler panels shall be flanged on one side 25mm (1") and secured to back of cabinet. The edge extending to wall shall be flat and fit into a double angle secured to wall. No visible mounting screws permitted.

2.3 FLOOR/WALL CABINET COMPONENTS

.1 Materials and Thickness: Use the following standard steel thickness for this furniture manufacturing:

.1 1.2mm (18 Ga) leveled prime grade furniture steel for sides, top, back, bottom, false bottom, dust caps and bases on tall storage cabinets.

.2 3mm (11 Ga) cold rolled steel for levelling device brackets on floor storage cabinets only.

.2 Wall Storage Cabinets Sliding Glass Door or Open Type:

.1 Cabinet sides, bottom and top shall be flat panels dieformed "U" shaped flange on front edge and a return flange on back edges. Provide top and bottom panels with 40mm (19/16") flanges on both ends with double returns. Reinforce front flanges on both sides and top with a flanged "U" shaped member. Both front side stile reinforcing channels shall contain a vertical row of shelf support clip holes 5mm (3/16") round or square and 13mm (1/2") o.c. Reinforce bottom with "U" channel.

.2 Design of cabinet shall enable it to be easily converted to a sliding glass door cabinet.

.3 Wall cabinets shall be provided with a flush bottom enclosure interlocking with front floor of cabinet as a telescoping panel with flange at rear and secured through the cabinet back.

.4 Provide shelves with edges turned down on 4 sides 25mm (1"), and return under on front and back by 25mm (1"). Provide shelf adjustment on 13mm (1/2") increments for full height of cabinet interior. Provide a minimum of four plated shelf clips per shelf. Provide shelves 914mm (36") and longer with 'HAT" channel reinforcement at front edge.

.5 Provide sliding glass doors in 6mm (1/4") sheet glass with "H" shaped extruded aluminium shoes fixed to and running the full width of the door bottom. Provide vinyl glazing channel fixed into shoe. Provide 2 removable spring steel and nylon wheel assemblies, one located at each end. The door assembly shall run on an inverted double "Y" shaped extruded aluminium track. Provide each door at top with 2 PVC guides running in double "U" shaped extruded aluminium track. One finger pull per door shall be ground into glass on side of door next to cabinet frame.

.6 Install bumpers on vertical reinforcement members of the cabinet frame.

.3 Wall Storage Cabinets; Sliding Metal Doors & Framed Glass Doors:

.1 Fabricate cabinet the same as above, with modified front side posts to accept sliding metal doors.

.2 Doors shall be guided at the bottom with a full width black PVC double "U" channel fixed to floor of cabinet.

.3 Upper track for sliding metal and framed glass doors shall be galvanized; doubletrack, "V" grooved, and painted to match furniture. Provide 2 suspended rollers per door, with special set of brackets for fixing to sliding doors. Nylon rimmed ball bearing rollers as specified for drawer track assemblies.

.4 3mm (1/8") glass shall be provided for frame glass doors.

.4 Wall Storage Cabinets: Hinged Metal Doors:

.1 Fabricate cabinets with two front side frames modified to minimize dust penetration. Provide intermediate exposed vertical members in a double "U" shaped channel. The front edges of the top panel shall have a channel formation reinforced with a flanged "U" channel. The exterior bottom panel shall have a channel formation at front and fitted with a flanged interior floor.

.2 Hinged metal doors.

.5 Floor Storage Cabinets; Sliding Glass Doors and Open Type:

.1 Fabricate cabinet bottom with vertical height divided into two equal sections, each with a set of sliding doors and track system. Provide a finished floor full width and depth of interior with return flanges turned down on all four edges in both upper and lower sections and welded in place. Fabricate cabinet floor flush with front flange.

.2 Provide a shelf separating upper and lower sections, with 40mm (19/16") flanges on all four sides, fixed and spot welded in place.
.3 Provide builtin toe space 100mm (4") high extending full width of cabinet recessed back 75mm (3") from front face with a 10mm(3/8") diameter steel threaded bolt type levelling device in each corner.
.4 Provide sliding glass doors in 6mm (1/4") sheet glass with "H" shaped extruded aluminium shoes fixed to and running the full width of the door bottom. Provide vinyl glazing channel fixed into shoe. Provide 2 removable spring steel and nylon wheel assemblies, one located at each end. The door assembly shall run on an inverted double "Y" shaped extruded aluminium track. Provide each door at top with 2 PVC guides running in double "U" shaped extruded aluminium track. One finger pull per door shall be ground into glass on side of door next to cabinet frame.

.6 Dust Caps:
.1 Dust caps shall be fabricated from 1.2mm (18 Ga) steel, and shall mount flush with the front edge of the cabinet and extend back at an angle of 30 degrees to a point perpendicular to the rear of the cabinet. Ends shall be finished and flanged so as to allow attachment to the cabinet below.

2.4 STEEL FURNITURE FINSISH

.1 Paint Performance data is available from manufacturer.

.2 All Steel furniture on this section shall be constructed of stanless steel with a #4 paintbrushed finish. Grain direction shall be horizontal except where cabinet dimensions do not permit.

PART 3 EXECUTION

3.1 INSTALLERS

.1 Installer Qualifications:
.1 Installer shall have a minimum of 5 years continued experience in installation or application of systems similar to those required for this project.
.2 Installer shall be authorized by either the distributor or manufacturer. Warranty will be void if unauthorized installer executes the installation.

3.2 EXAMINATION

.1 Site Verification of Conditions:

.1 Casework will not be delivered or installed until the following conditions have been met: a) Building must be enclosed (windows and doors sealed and weathertight);

.2 An operational HVAC system that maintains temperature and humidity at occupancy levels must be in place;

.3 Ceiling, overhead ductwork and lighting must be installed;

.4 Site must be free of any further construction such as "wet work."

.5 Required backing and reinforcements must be installed accurately and the project must be ready for casework installation.

3.3 INSTALLATION

.1 Casework Installation:

.1 Casework shall be set with components plumb, straight and square, securely anchored to building structure with no distortion. Concealed shims shall be used as required.

.2 Cabinets in continuous runs shall be fastened together with joints flush, uniform and tight with misalignment of adjacent units not to exceed 1/16 of an inch.

.3 Wall casework shall be secured to solid material, not lath, plastic or gypsum board.

.4 Top edge surfaces shall be abutted in one true plane. Joints are to be flush and gap shall not exceed 1/8 of an inch between tops units.

.5 Casework and hardware shall be adjusted and aligned to allow for accurate connection of contact points and efficient operation of doors and drawers without any warping or binding.

.2 Countertop Installation:

.1 Countertops are to have been fabricated in lengths according todrawings, with ends abutting tightly and sealed with corrosion resistant sealant.

.2 Tops will be anchored to base casework in a single true plane with ends abutting at hairline joints with no raised edges at joints.

.3 Joints shall be factory prepared having no need for infield processing of top and edge surfaces.

.4 Joints shall be dressed smoothly, surface scratches removed and entire surface cleaned thoroughly.

3.4 CLEANING

.1 Ensure all products are unsoiled and match factory finish. Remove or repair damaged or defective units.

.2 Clean all finished surfaces, including drawers and cabinet shelves, and touch up as necessary.

.3 Countertops shall be cleaned and free of grease or streaks.

3.5 PROTECTION

.1 Counter tops and ledges shall be protected with 1/4 inch ribbed cardboard for the remainder of the construction process.

.2 Examine casework for damaged or soiled areas; replace, repair, and touchup as required.

.3 Touchup, repair or replace damaged products before Substantial Completion.

END OF SECTION

CFIA LABORATORY RENOVATION

Commissioning Plan
Rev. 2

Prepared by

HFM

A CERTIFIED BUILDING COMMISSIONING FIRM

CBCF

The Association of Energy Engineers

May 28, 2015

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Executive Summary

Commissioning is a collaborative process which involves all the stakeholders including, the occupant, the owner, the facility manager, the design team and the construction team. By extension, equipment manufacturers and suppliers are also involved. The commissioning program is led by the Commissioning Agent (the CA) and provides documented confirmation that building systems function according to criteria set forth in the project drawings and specifications to satisfy the owner's operational needs (Owner's Project Requirements).

The CFIA Laboratory Renovation project encompasses a customized commissioning process designed to achieve successful completion of the project and meet the needs of the stakeholders and end-users.

Preparation for the commissioning process starts during the design phase and initially includes the following activities:

- Development of commissioning specification for inclusion in main specifications package
- Commissioning focussed review of the design documents

During the construction phase the following are the major activities which are performed:

- Participation in focused commissioning meetings
- Reviewing contractor submittals (Shop Drawings)
- Maintain the Commissioning Progress Matrix Form (CPM Form) and provide input to the Commissioning Schedule
- Witnessing/participating in selective equipment start-ups
- Develop, coordinate and conduct tests to rigorously challenge the equipment, the systems and the control sequences to confirm their functionality and performance
- Reviewing contractor submittals (O&M Manuals, Training Plan) and witness training

Post construction activities include:

- Follow-up testing to ensure that Items of Concern (minor deficiencies) are resolved
- Opposite season testing of mechanical systems as required

This Commissioning Plan will be submitted for review by the entire Commissioning Team. Through meetings and discussions, all building systems and all procured equipment commissioning activities will be compiled as part of the Commissioning Plan. This will result in the completion of an agreed Final Commissioning Plan, which will then be integrated into the overall project schedule.

Table of Contents

1.0 Overview

1.1 Project Overview

This project covers the renovation of rooms 115, 164, 165, 225, and clean rooms on Level 3 at 2301 Midland Avenue, Scarborough. Due to the requirement for the building to remain in operation throughout the duration of the project, the laboratory renovations will occur in three (3) phases. Phase 1 Construction includes work associated with rooms 115, 164, and clean rooms on Level 3. Phase 2 Construction includes work associated with room 165. Phase 3 Construction includes work associated with room 225. Each phase shall be completed and fully commissioned, fully operational and staff training completed prior to start of next phase.

1.2 Purpose of the Commissioning Plan

This plan governs the commissioning process for the CFIA Laboratory Renovation Project described above.

This plan does not provide a detailed explanation of required testing procedures. The detailed testing requirements and procedures are found in the Specifications, and any applicable Codes or Standards. This Commissioning Plan is a 'living' document and will be updated throughout the course of the project.

1.3 Commissioning Scope

Commissioning is the systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs.

Commissioning during the project will involve the completion of a number of activities, mainly by the contractors and the Commissioning Agent such as but not limited to:

- Ensure that Owner's requirements are met through Design and Construction document reviews;
- Management involving planning, monitoring, control, reporting and communications that is integrated with other project and client outputs & processes;
- Ensure that applicable equipment and systems are installed properly and receive proper start-up and adequate operational checkout by installing contractors.
- Verify and document proper functionality and performance of equipment and systems.
- Ensure that O&M documentation left on site is complete.
- Ensure that the Owner's and/or service provider's operating staff are adequately trained

1.4 Abbreviations and Definitions

The following are common abbreviations used in this document.

A/E	Architect and Design Engineers	**GC**	General Contractor
CA	Commissioning Agent	**EC**	Electrical Contractor
CC	Controls Contractor	**MC**	Mechanical Contractor
FT	Functional Performance Test	**PF**	Pre-functional Test sheet
Cx	Commissioning	**Cx Plan**	Commissioning Plan document
TAB	Test and Balance Contractor	**Subs**	Subcontractors to General

1.5 Equipment/Systems to be Commissioned

The following equipment/systems will be commissioned as part of this project:

a) Building Automation System
b) Fume Hoods
c) Hot Water Reheat Coils
d) Air Flow Valves
e) Cooling Coil
f) Humidifiers
g) Panelboards
h) Lighting Control

2.0 General Building Information

Project Name:	CFIA Laboratory Renovation
Location:	2301 Midland Avenue, Scarborough, Ontario
Building Type:	Laboratories & Clean Rooms
Gross Floor Area (sqft)	
Construction Period	To be determined

3.0 Project Team

3.1 Project Directory

A Project Directory has been included as Appendix A: Project Directory of this Plan.

3.2 Team Members

The members of the commissioning team consist of the CA (the CA), Thompson Rosemount Group (TRG) Design Consultant Representative, PWGSC Departmental Representative (Project Manager), PWGSC Commissioning Specialist, General Contractor, sub-contractors, and testing agencies.

3.3 General Management Plan

The CA generally coordinates commissioning activities through the PM. The CA's responsibilities, along with all other contractors' commissioning responsibilities are detailed in the specifications. The specifications will take contractual precedence over this Cx Plan. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Refer to the management protocols section below.

3.4 Management Protocols

The following management protocols will be used on this project:

Issue	Protocol
For requests for information (RFI) or formal documentation requests:	The CA goes first through the GC.
For minor or verbal information and clarifications:	The CA goes direct to the informed party.
For notifying contractors of deficiencies:	The CA documents deficiencies through the GC, but may discuss deficiency issues with contractors prior to notifying the GC.
For scheduling functional tests, performance tests, or training:	The CA will provide input for, and coordinate training and testing, but scheduling shall be coordinated through the GC.
For scheduling commissioning meetings:	The CA selects the date and schedules through the GC.
For making a request for significant changes:	The CA has no authority to issue change orders.
For making small changes in specified sequences of operations:	The CA may not make changes to specified sequences without approval from the A/E.
Subcontractors disagreeing with requests or interpretations by the CA shall:	Try and resolve with the CA first. Then work through GC who will work with CA directly or through the PM to resolve the situation.

3.5 General Descriptions of Commissioning Roles

Party	General Commissioning Role Description
Commissioning Agent	A qualified professional, the Cx. Agent represents both PWGSC and HC's interests who schedules and coordinates all commissioning activities during project delivery stage as well as post-occupancy commissioning. The Cx. Manager is also responsible for the preparation of the Commissioning Plan, The Commissioning Specifications, the Commissioning Schedule, and the preparation and completion of all applicable commissioning forms which include the Product Information (PI) Forms and Performance Verification (PV) Report Forms for the systems/equipment to be commissioned; review of applicable shop drawings; witnessing of all commissioning testing including startups and functional performance verification testing and post-occupancy testing for the systems/equipment to be commissioned; the timely submission of completed commissioning forms to PWGSC Project Manager for review and approval; preparation and submission of the Final Commissioning Reports.
TRG Design Consultant Representative	Provides all design information required for commissioning to meet HC's functional requirements and maintain design intent of the base building systems, prepares the Design Intent and Commissioning Brief and submits to Cx. Agent for coordination of the Commissioning Plan. The Design Consultant will verify that the base building and HC's functional requirements are correctly interpreted during the design stage and contract documents, and that the building systems operate consistently at peak efficiencies, under all normal load conditions. The Design Consultant will liaise with the Cx. Agent and incorporate the commissioning requirements and standards into the design and construction contract documents.
PWGSC Departmental	Overall responsibility of the project delivery including approval of commissioning

Party	General Commissioning Role Description
Representative (Project Manager)	budget and schedule, resolution of contract disputes, approval of commissioning report and certification of final completion.
PWGSC Commissioning Specialist	Reviews project deliverables and provide in-house technical support to the Project Manager on quality assurance and quality control to ensure conformity to department's standards and code requirements. Responsible for reviewing and providing inputs on all commissioning activities during the development, implementation and post construction stage of the project to conform to PWGSC's commissioning standards.
BGIS Commissioning Representative	Represents Health Canada's (Building Owner's) base building interests, provides operational requirements that affect base building systems and is responsible for reviewing and providing input.
General Contractor	The General Contractor shall co-ordinate with the Cx. Agent to arrange personnel, sub-contractor(s) and qualified testing agencies for conducting pre-startup tests, equipment startup and testing, system startup and testing, TAB, functional performance verification, post-occupancy testing, O&M training sessions; submission of shop drawings, test results, as-built drawings and the operating and maintenance (O&M) manuals.
Mechanical/ Electrical Contractors and their Sub-trades	Responsible for construction, providing O&M documentation and demonstration of facility features, systems, equipment and processes in accordance with design requirements. Completes pre-functional tests and assists in execution of functional testing. Development of checklists, startup and testing procedures for specialty systems. Responsible for operation of facility systems for demonstration purposes until turnover to owner. Provides and videotapes training sessions.
Manufacturers	The equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform contracted startup. Participate/provide Facility Management training.
Facility Management Staff	Participate in Commissioning meetings and witness functional testing at their discretion. Participate in training.

4.0 Design Phase Commissioning Program

This section describes commissioning activities that are performed during the design stage of the project.

4.1 Commissioning Specifications – Development

The Commissioning Specifications detail the commissioning requirements for all the equipment and systems and the responsibilities of the involved parties. These specifications follow the intent of ASHRAE Guidelines and specifically detail commissioning processes, included but not limited to; documentation requirements and formats, pre-functional and functional test procedures, acceptance criteria, deficiency resolution, training and O&M manual requirements. As required, the CA will assist in developing the full commissioning specifications and coordinate with the architects and engineers for integration into the project specification package.

4.2 Summary of Written Work Products

Product	Created By	Product Description	Reviewed By	Approved By	Product Assigned In
Commissioning Specifications	Consult./ CA	Details commissioning requirements for all equipment/systems and responsibilities of involved parties.	Consult./ CA	Consult.	N/A
Commissioning Plan	CA	Describes the approach to commissioning, roles and responsibilities, and work products for the project	Project Team	Owner	N/A

5.0 Construction Phase Commissioning Program

The section describes commissioning activities that will be carried out during the construction stage of the project. Generally the CA will oversee commissioning procedures and review relevant commissioning documents/submittals for best practice procedures and to ensure functionality in accordance with the design intent.

5.1 Meetings

5.1.1 Commissioning Scoping Meeting

The CA will conduct a commissioning scoping meeting. In attendance will be the respective representatives of the Owner, General Contractor, A/E and the mechanical, electrical, controls and TAB Contractors. At the meeting, commissioning parties will be introduced to one another, the commissioning process will be reviewed, and management and reporting lines will be determined. The required submittals and the Final Work Products list will be discussed. Also covered will be the general list of each party's responsibilities; who is responsible to develop the startup plan for each piece of equipment, and the proposed commissioning schedule. The meeting is intended to increase understanding by all parties of the commissioning process and their respective responsibilities. The meeting will provide the CA with additional information needed to finalize the *Cx Plan*, including the commissioning schedule.

5.1.2 Commissioning and Miscellaneous Meetings

After the initial commissioning scoping meeting, The CA will conduct commissioning meetings with the commissioning team on a regular basis to review the status of commissioning and identify any risks or issues

that may arise during the project cycle. The frequency of these commissioning meetings will increase as the project gets closer to functional testing. Commissioning meetings will be scheduled by the CA as required.

The CA will attend selected planning and job-site meetings in order to remain informed on the construction progress and to update parties involved in commissioning. The CA may review construction meeting minutes, change orders or SI's for the same purpose.

5.2 Contractor Submittals and Documentation

The CA will be provided with drawings, shop drawings, change notices, etc., as required. The CA will review contractor submittals relative to commissioning issues expressed in the contract documents; not for general contract compliance (which is the A/E's responsibility). The GC shall also provide the CA with information regarding substitutions, RFI's, and any Special Submittals, Notifications and Clarifications

The CA will be notified of any new design intent or operating parameter changes, added control strategies, or other change orders that may affect commissioned systems. The controls contractor shall provide the CA with complete BAS control drawings along with a full points list with details. Thirty (30) days prior to performing Functional Testing, the Subs provide the CA full details of the procedures. As the phases of the TAB are completed, the draft TAB report is provided to the CA with full explanations of results, data table legends, etc. The final TAB report, approved by the Engineer of Record shall be provided to the CA upon completion.

The submittals to the CA do not constitute compliance for submittals for the O&M manuals. Documentation requirements for the O&M manuals are the A/E's responsibility.

5.3 Site Observations

The CA will make periodic visits to the site to witness equipment and system installations. These visits will be coordinated with the GC. Periodic work progress reports must be submitted to the Project Manager and PWGSC Commissioning Specialist.

5.4 Product Information (PI) Forms

The CA will develop and complete Product Information (PI) Forms for this project. PI forms are intended to record full details of manufacturer's product information, construction, nameplate data, appurtenances, components, controls and all other purchasing data. The CA will:

1. Complete the form, including start-up and warranty data, immediately upon delivery to site
2. Consult with TRG Design Consultant Representative/BGIS Commissioning Representative for equipment and/or system identification number. Include the appropriate identification number on all PI forms.
3. The completed form shall then be signed off by the Cx. Agent.
4. Submit completed PI form to PWGSC Departmental Representative for review and approval.
5. Include PI forms in the Final Commissioning Report

5.5 Equipment Start-up and Pre-Functional Testing

5.5.1 Installation and Pre-Functional Checklists

Installation and Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., oil levels OK, fan belt tension, labels affixed, gages in place, sensor calibration, etc.). However, some Pre-Functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as checking the rotation of motors, or measuring the voltage imbalance on a three phase pump motor of a chiller system). The pre-functional test forms are

developed by the CA and completed by the installing contractor. Sample pre-functional test forms have been provided as Appendix B: Sample Pre-Functional Test.

Installation and Pre-functional checklists are important to ensure that the equipment and systems are installed and operational, in order to allow for functional testing to proceed without unnecessary delays. Each piece of equipment shall receive full Pre-Functional checkout by the Contractor prior to formal Functional Testing of equipment or subsystems of the given system.

5.5.2 Execution of Installation and Pre-Functional Checklists and Startup

Start-up Plans are simply the manufacturer's pre-start and start-up procedures (sometimes performed by approved mechanical contractors).

Four weeks (minimum) prior to startup, the Subs and vendors schedule startup and initial checkout with the GC and the CA. The startup and initial checkout are to be directed and executed by the Sub or vendor. The CA may observe the procedures for primary equipment.

The party responsible for start-up shall submit the completed start-up report to the GC and the CA. A hard-copy of the start-up report shall be appended to the associated pre-functional and remain on site in the pre-functional binder.

5.5.3 Items of Concern/Deficiencies and Non-Conformance

The Subs shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The procedures form and deficiencies shall be provided to the CA and the GC within two days of test completion. The CA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items, involving the GC and others as necessary. The installing Subs or vendors shall correct all areas that are deficient or incomplete according to the checklists and tests.

5.6 **Controls Checkout Plan**

The controls contractor develops and submits a written step-by-step plan to the CA which describes the process they intend to follow in checking out the control system and the forms on which they will document the process. The controls contractor will also meet with the TAB contractor prior to the start of TAB and review the TAB plan to determine the capabilities of the control system for use in TAB. The controls contractor shall also provide a technician qualified to operate the controls to assist the TAB contractor in performing TAB.

All required controls pre-functional test forms, calibrations, point-to-point verification, start-ups and selected functional tests of the system shall be completed by the controls contractor and reviewed by the CA. The controls contractor shall execute the tests and trend logs assigned to them in Division 25 of the specifications, and remain on site for assistance in functional testing of any systems that are controlled or monitored by the building automation system.

5.7 **Testing and Balancing**

The TAB contractor shall submit the forms that they plan to use and equipment calibration certificated to the CA and the controls contractor eight weeks prior to starting the TAB. A meeting will be held with the TAB, CC, MC, GC and the CA eight weeks prior to starting to approve the proposed strategy that the TAB will utilize to balance the Air and Water systems throughout the facility. All members will review the plan and approach for understanding and coordination issues and may comment, but does not "approve". The controls contractor shall review the feasibility of using the building control system for assistance in the TAB work. The TAB shall submit weekly written reports of discrepancies, contract interpretation requests and

lists of completed tests to the CA and GC during the process of TAB. This will facilitate quicker resolution of problems and will result in a more complete TAB before functional testing begins.

5.8 **Functional Testing**

5.8.1 Functional Testing Overview

Functional testing is the dynamic testing of systems (rather than just components) under various levels of operation (e.g. the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure set point). Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The installing contractor develops the functional test procedures which are based on the approved sequence of operations. Fundamentally, the intent is to verify that each system sequence of operations is implemented correctly. The CA coordinates, oversees and reviews completed tests, which are performed by the installing contractor or vendor.

The CA shall approve the schedule for functional tests through the GC and affected Subs. the CA shall oversee and direct the functional testing of all equipment and systems identified in the specifications and of this Commissioning Plan. The Subs shall execute the tests. Testing proceeds from components, to subsystems, to systems and finally to interlocks and connections between systems. Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers.

5.8.2 Scope of Testing

The testing requirements specifications for Divisions 21 through 28 provide overview testing scope for each piece of commissioned equipment. The systems to be commissioned have been identified in Section 1.5 of this Plan.

5.8.3 Functional Test Development

The CA will develop the functional test scripts after receiving the approved sequence of operation for the equipment/system. A sample functional test form has been appended as Appendix C: Sample Functional Test Sheet.

5.8.4 Sample Functional Testing Scope Outline

The following table outlines sample functional testing scope; it has not been tailored to this project at this point. Once the approved controls package is received by the CA, project specific functional test packages will be created.

System or Equipment	**Equipment or Component Tested**	**General Description of Modes and Functions to Test**	**Who Executes Test**
Air handling system	Terminal units	Verify damper and fan sequences during heating, cooling, occupied, unoccupied, verify flow	Mech. leads with help from Controls
General Fans	Central exhaust fans, controls	Occupied, unoccupied, local controls, overrides, schedules, central controls	Mech.

System or Equipment	Equipment or Component Tested	General Description of Modes and Functions to Test	Who Executes Test
Building Automation System	Schedules, sequences, lockouts, alarms, interlocks, control strategies, trending	All sequences of control for HVAC equipment and lighting controls,	Control
Specialty Fans	Fume Hoods	Capacity, varying differential pressures, interlocks, safeties	Installing contractor, CA, 3rd Party Testing
TAB	Air and water TAB work	Primary air and water flows and terminal flows	TAB

5.8.5 Functional Test Pre-Requisites

For any given system, prior to performing functional testing, the CA shall wait until the following items are received in order to confirm the system is ready for functional testing:

a) Installation and Pre-functional Checklists – Installation and Pre-Functional checklists must be completed and submitted with the necessary signatures and associated start-up report amended.
b) Approved TAB Report – The air balancing and water balancing shall be completed, debugged, and approved by the A/E before functional testing of air-related or water-related equipment or systems.
c) Controls Checkout – The control system shall be tested before it is used to verify performance of other components or systems. The controls contractor shall provide documented point-to-point verification and sequence verifications.

5.8.6 Facility Staff Participation

The Owner's facilities operating and maintenance (O&M) staff are encouraged to attend and witness the testing process.

5.9 **Deficiency/Items of Concern Reporting**

Corrections of minor deficiencies identified are made during the tests at the discretion of the CA. Deficiencies or non-conformance issues shall be noted and reported to the GC and the Owner. Subs shall correct deficiencies and notify the CA of the corrections. The CA shall schedule retesting through the GC. Decisions regarding deficiencies and corrections will be made between the CA or the GC and the Design Engineers. For areas in dispute, final authority, resides with the Owner. the CA shall recommend acceptance of each test to the Owner and the GC.

the CA shall generate, update, and distribute an Items of Concern Report throughout the pre-functional and functional testing period. For each Item of Concern identified, the report will include the following:

a) Report Number
b) Date Item Discovered
c) Description of the Item
d) Responsible Party
e) Status of the Item (i.e. Open or Closed)
f) Responsible Party Comments
g) CA Comments

5.10 Cost of Retesting

The cost for the Sub to retest a pre-functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.

For a deficiency identified, not related to any Pre-Functional test sheet or start-up fault, the following shall apply: the CA will direct the retesting of the equipment once at "no charge" to the GC for their time. However, the CA's time for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.

The time for the CA and the GC to witness any retesting required because a specific Pre-Functional test sheet or start-up test item reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the responsible contractor, who may choose to recover costs from the party responsible for executing the faulty Pre-Functional test.

5.11 Performance Verification Report Forms

Performance Verification (PV) Report Forms will capture all design criteria, design intents, testing, adjusting, balancing and performance verification (PV) test results and all other data relating to components, equipment, sub-systems, systems and integrated systems. The PV forms will be completed in conjunction with the Functional Test forms to include provisions for:

1. confirming operation as per design criteria and design intents,
2. identifying variances between design and operation and reasons for these variances,
3. verifying operation in all specified normal and emergency modes and under all specified load conditions,
4. inclusions of analytical and other substantiating data,
5. verifying all reported results,
6. inclusions of additional data not previously specified but required by the Cx. Agent for further sub-system,
7. system and integrated system testing.

5.12 O&M Manuals and Warranties

The GC shall obtain written warranties from equipment manufacturers and contractors, Operation and Maintenance (O&M) manuals from subs, and review the O&M manuals, documentation and as-built for systems that were commissioned to verify compliance with the Specifications. The CA shall recommend approval and acceptance of these sections of the O&M manuals to the GC and Owner. Final approval of all O&M documentation and warranty shall be the responsibility of the A/E and Owner.

5.13 Standard Operating Procedure Manuals

The Standard Operating Procedures (SOP) Manuals will be produced by the Design Consultants and reviewed by the CA.

5.14 Training and Orientation of Owner Personnel

5.14.1 Training Overview

Owner training and orientation on equipment and systems provided by the Contractor is accomplished in three general steps using three forms.

a) Overall Plan - After reviewing the specifications, and after interviewing facility staff, if necessary, the subs shall fill out a table listing all the equipment for which training or orientation will be provided and submit through the GC to the CA & Owner for review.

b) Specific Training Agendas - For each piece of equipment or system for which training is provided, the Subs shall fill out the *Training and Orientation Agenda* for approval by the Owner and the CA. See below for sample. This section includes some of the information regarding the scope of training and the intended audience, for reference by the trainer in developing the training agenda. In particular, the controls contractor will provide brief training on controls in the same session with the mechanical training for equipment controlled by the building automation system.
c) Training Record - For each piece of equipment, prior to training, the Contractor shall provide each trainer a form in which the trainer documents each training session (duration and general subjects covered). The trainer shall sign for the session and obtain the signature of each trainee. The trainer shall also check off subjects covered on the Agenda. When the training is complete, the Contractor shall provide a copy of the *Training and Orientation Record*, and the trainer's Agenda, to the Owner and the CA.

5.14.2 Training Responsibilities

The following training provides an example as to the typical responsibilities for training:

a) Architect - The architect will provide a general overview of the facility, its use, special features, tenant and public considerations, etc.
b) Mechanical Design Engineer - The mechanical designer will provide an overview of the major systems and equipment in the facility, including for each system: the design intent, why the system was chosen, an overview of its operation, and interactions with other systems, any special areas to be aware of, issues regarding future expansion and remodeling, etc.
c) Electrical Design Engineer - The electrical designer will provide an overview of the major electrical systems and equipment in the facility, particularly the lighting & daylighting control systems, focusing on the design intent, why the system was chosen, an overview of its operation, and interactions with other systems, any special areas to be aware of, issues regarding future expansion and remodeling, etc.
d) Equipment Manufacturer or Installing Contractor - For each commissioned system, comprehensive training to convey the operation and maintenance procedures, as well as any equipment features that may be unique to the project shall be delivered by the installing contractor and/or equipment manufacturer as appropriate.
e) Controls Contractor - The controls contractor shall provide an overview of the building automation system (BAS) as well as hands-on training for owner's staff.

OVERALL STAFF TRAINING AND ORIENTATION PLAN					
Equipment / System	**Spec #**	**Total Hours**	**Responsible Contractor**	**Trainers' Company**	**Planned Training Date(s)**

5.15 Summary of Written Work Products

The following table provides a summary of the written work products

Product	Created By	Product Description and Form	Reviewed By	Approved By	Product Assigned In
Scoping Meeting Minutes	CA	Minutes and notes of the commissioning scoping meeting	All Cx team	All	Cx Specs
Final Cx Plan	CA	Final Cx Plan	All Cx team	PM	Cx Plan
Equipment submittals (Shop Drawings)	All Subs	Shop drawings for all equipment and systems to be submitted to the CA	Consult.	Consult.	Cx Plan
Product Information (PI) Forms	CA	Intended to record full details of manufacturer's product information, construction, nameplate data, appurtenances, components, controls and all other purchasing data	Owner	Owner	N/A
Pre Functional tests sheets	CA	Pre-Functional tests are developed by the CA and completed by the installing contractor	Subs	CA	Cx Plan
Start-up and initial checkout plans	All Subs and CA	Specific listing of procedures for combining CA pre functional checklists with Sub's startup and checkout.	CA	CA	Cx Plan
Start-up and initial checkout reports	All Subs	Filled out pre functional checklists, startup and initial checkout	CA	CA	Cx Plan
Site Instructions	GC; PM	Site Instructions that affect Commissioned equipment shall be forwarded to the CA	GC	GC	Cx Plan
Items of Concerns/ Deficiency reports	CA	List of deficiencies and non-compliance with Contract Docs identified during Commissioning	PM from CA	CA	Cx Plan
Functional test forms	CA	Full description of test procedures in accordance with A/E approved Systems "Sequence of Operations"	CA	PM	Cx Plan
O&M manuals	GC and Subs	Documentation of design, equipment, operations and maintenance, as-builts, etc.	CA reviews on-site	A/E	Cx Plan
Performance Verification (PV) Report Forms	CA	To document all design criteria, design intents, testing, adjusting, balancing and performance verification (PV) test results and all other data relating to components, equipment, sub-systems, systems and integrated systems	Owner	Owner	N/a
Standard Operating Procedure Manual	Consult.	Manual detailing the standard operating procedures for the facility.	CA	Owner	Cx Plan

6.0 Post Occupancy Phase Commissioning Program

The following section details the commissioning process during the post occupancy or operations phase of the project:

6.1 Deferred or Seasonal Testing Execution

During the warranty period, seasonal or deferred testing will be performed (if applicable). Tests shall be executed and deficiencies corrected by the appropriate Subs, witnessed by facilities staff and THE CA. Any final adjustments to the O&M manuals and as-built drawings due to the testing shall be made.

6.2 Final Commissioning Process Report

The CA will develop the Final Commissioning Report which shall include the following:

a) Complete assessment of the project
b) Lessons learned from this project and any necessary recommendations
c) Variances between the actual and planned levels of performance
d) Evaluation of the commissioning process
e) Components and systems which were not commissioned and the reasons
f) Remedial work plan outlining recommended follow-up actions or projects to be undertaken by PWGSC
g) Other related issues

6.3 Near Warranty Post-Occupancy Review

The CA will coordinate with the owner and the O&M staff to review the facility and its performance within 10 months of substantial completion. All unresolved construction deficiencies as well as any deficiencies identified in the post occupancy review should be documented and corrected under manufacturer or contractor warranties. The CAs review of the building operations staff and occupants should identify any problems in operating the buildings as originally intended.

6.4 Summary of Written Works

Product	Created By	Product Description and Form	Reviewed By	Approved By	Product Assigned In
Seasonal or Deferred Test Results	CA	A report summarizes the results of any seasonal or deferred tests will be developed an appended to the Final Commissioning Report	Owner, PM	Owner, PM	Cx Specs
Final Commissioning Report	CA	Final report summarizing commissioning process, results, deficiencies, etc.	PM	PM	Cx Plan
Near Warranty Review Report	CA	Report on the results of the CA's review with facility staff 10 months after Substantial Completion.	Owner, PM, GC & Subs	Owner	Cx Plan

Appendix A: Project Directory

<UNDER DEVELOPMENT>

Appendix B: Sample Pre-Functional Test

Fan Pre-Functional Test Sheet

«Tag»
Service: «Service»
Location: «Location»

1. Submittal / Approvals

Submittals. The above system and/ or equipment integral to it are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below. This pre-functional checklist is submitted for approval, subject to minor outstanding items; none of the minor outstanding items restrict the safe and reliable execution of the functional tests. The «Role» shall determine the readiness of the system/ equipment for functional testing based on the review of this pre functional checklist. The final sign off will be provided by the «Role» once this pre functional checklist has been completed in its entirety.

Mechanical Contractor	Date	Controls Contractor	Date
Electrical Contractor	Date	Sheet Metal Contractor	Date
TAB Contractor	Date	General Contractor	Date

Pre-functional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- Contractors assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted in a separate deficiency list.

«Role»	Date	Owner's Representative	Date

2. Requested Documentation Submitted

Check if Okay, enter comment if item not available.

Check	«Tag»	Comments	Contr.
Manufacturer's cut sheets			
Performance data (fan curves)			
Installation and Startup manual and plan			
Sequences and control strategies			
O & M Manuals			
Warranty Certificates			

Documentation complete as per contract documents _____ **YES** _____ **NO**

3. Model Verification

Complete the following table and verify information matches.

	«Tag»			
	Design	**Shop Dwg.**	**Actual**	**Comments**
Fan Information				
Fan Manufacturer				
Model Number				
Serial Number				
Type				
Motor Information				
Motor Manufacturer				
Model Number				
Serial Number				
Belts				
Motor (HP)				
Voltage per Phase				
Motor Speed (RPM)				
Motor Loading (Amps)				
Starter Information				
Starter Manufacturer				
Serial Number				
Volts/Amp/HP				
Fan System Performance				
Air Flow-Fan (L/S)				
Static Press (Pa.)				
Fan Speed (RPM)				

The equipment installed matches the specifications of given trade _____ **YES** _____ **NO**

4. Physical Installation Checks

Check	«Tag»	Comments	Contr.
Cabinet and General Installation			
Permanent labels affixed			
Casing condition good: no dents, leaks, door gaskets installed			
Mountings checked and shipping bolts removed			
Vibration isolators installed			
Equipment guards installed			
Pulleys aligned			
Belt tension correct			
Plenums clear of debris			
Fans rotate freely			
Fire and balance dampers installed			
Backdraft dampers installed, per drawings, and operate freely			
Duct system complete			
Electrical			
Electrical connections complete			
Disconnect switch installed			
Overload heaters in place			
Control connections complete			

The checklist items of Part 4 are all successfully completed for given trade _____ **YES** _____ **NO**

5. Operational Checks

(These augment manufacturer's list. This is not the functional performance testing)

Check	«Tag»	Comments	Contr.
Fan rotation correct			
Electrical interlocks verified			
Fan status indicators functioning			
No unusual vibration or and noise			
The disconnect switch properly operates			
After 24 hours of operation, recheck belt tension and alignment			

The checklist items of Part 5 are all successfully completed for given trade _____ **YES** _____ **NO**

6. Electrical Verification

Check	Phase A	Phase B	Phase C
Record motor running amps.			
Use a Meggar to measure the condition of the motor windings. Record the resistance between the motor windings and ground.			
Record operating phase voltages			

The checklist items of Part 6 are all successfully completed for given trade _____ **YES** _____ **NO**

7. BAS Sequence of Operation & Field Panel Checkpoints

Check	«Tag»	Comments	Contr.
Specified sequences of operation and operating schedules have been implemented with all variations documented			
Specified point-to-point checks have been completed and documentation record submitted for this system			

The checklist items of Part 7 are all successfully completed for given trade _____ **YES** _____ **NO**

8. Sensor and Actuator Calibration

All field-installed temperature, relative humidity, CO, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on this piece of equipment shall be calibrated and documented. All test instruments shall have had a certified calibration within the last 12 months: Y/N _____. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

Sensor or Actuator & Location	Location OK	1st Gage or BAS Value	Instrument Measured Value	Final Gage or BAS Value	Pass Y/N?		Sensor or Actuator & Location	Location OK	1st Gage or BAS Value	Instrument Measured Value	Final Gage or BAS Value	Pass Y/N?

Gage reading = reading of the permanent gage on the equipment. BAS=building automation system. Instrument = testing instrument. Visual = actual observation. The Contractor's own sensor check-out sheets may be used in lieu of the above, if the same recording fields are included and the referenced procedures are followed.

All sensors are calibrated within required tolerances _____ **YES** _____ **NO**

Notes:

1.

2.

3.

4.

— END OF CHECKLIST —

Appendix C: Sample Functional Test Sheet

EXHAUST FANS:

Unit Tag: ***System:***

Components Included: ____ BAS ____ Exhaust Fan ___ Local Controller

1. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This pre-functional checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed. ___ List attached.

Participants

Mechanical Contractor	Date		
Controls Contractor	Date		
TAB Contractor	Date		

Pre-functional checklist items are to be completed as part of startup & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- If this form is not used for documenting, one of similar rigor shall be used.
- Contractors assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.
- "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CA = commissioning agent, CC = controls contractor, EC = electrical contractor, GC = general contractor, MC = mechanical contractor, SC = sheet metal contractor, TAB = test and balance contractor, ____ =_____.

Approvals. This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

Commissioning Agent	Date		

2. Pre-Functional & Pre-Requisite Checklists

a. The following systems have been started up and startup reports and pre-functional checklists submitted and approved ready for functional testing:

_____ Exhaust fan system _____ BAS/OEM panel _____

_____ _____ _____

Site checks of the Pre-functional checklist and startup reports completed successfully. Pass Y/N? _____

b. ___ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.

_____ _____
Controls Contractor Date

c. ___ Duct work and dampers complete.

d. ___ Vibration control report approved (if required).

e. ___ Test and balance (TAB) completed and approved for the hydronic systems and all terminal units.

f. ___ All A/E punchlist items for this equipment corrected.

g. ___ These functional test procedures reviewed and approved by installing contractor.

h. ___ Safeties and operating ranges reviewed.

i. ___ Test requirements and sequences of operation attached.

j. ___ Schedules and setpoints attached.

k. ___ False loading equipment, system and procedures ready (chillers, boilers, cooling coils, control loops, over-ride on supply air dampers, etc.)

l. ___ Have all energy saving controls strategies, setpoints and schedules been incorporated that this equipment and control system are capable of? If not, list recommendations below.

_____

m. ___ **Control Program Review.** Review the software control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.

n. ___ Record all values for current setpoints (SP), control parameters, limits, delays, lockouts, schedules, etc. Changed to accommodate testing, record all values below.

Table 1

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Exhaust fan Status		
Exhaust air damper		

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Outdoor air damper		
Time of day schedule		

3. Sensor calibration Checks.

Check the sensors listed below for calibration and adequate location. This is a sampling of calibrations done during Pre-Functional Test Sheets.
"In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS) compared to the test instrument-measured value is within the tolerances specified. If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Record all values in Table 2 below.

Table 2 - [1]Sensor location is appropriate and away from causes of erratic operation.

Sensor & Location[1]	BAS Value	Instrument Measured Value	Pass Y/N?
Room temperature sensor			

4. Device Calibration Checks.

The actuators or devices listed below are checked for calibration. This is a spot check on a sample of the calibrations done during Pre Functional checklist reviews and startup.
"In calibration" means observing a read-out in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix

Record all values in Table 3 below

Table 3

Device or Actuator	Procedure/State	BAS Value	Site Observation	Pass Y/N
Exhaust Fan	Enable (Start)			
	Disable (Stop)			
	Status (On) – current switch			
	Status (Off) – current switch			
Outdoor Air Damper	Enable (Open)			
	Disable (Close)			
	Status (On) – end switch			
	Status (Off) – end switch			
Exhaust Air Damper	Enable (Open)			
	Disable (Close)			
	Status (On) – end switch			
	Status (Off) – end switch			

5. Test and Balancing Review

Obtain the Testing and Balancing reports from the Mechanical Contractor. Perform a review of the approved design, shop drawing and TAB actual data. Any values that exceed the specification requirements (typically ±5%) between manufacturer's data and actual data may indicate problems and may require further investigation. All readings outside the ±5% range must be submitted to the Engineering Consultant for approval. Similar tests can be completed annually to verify and ensure continued efficient Unit Heater operation by comparing curve fit regressions of current operation with that of the original benchmarks

Record all values in Table 4 below

Table 4

EXHAUST FAN –
Service:

Location	EXHAUST FAN DATA			
	DESIGN	**SHOP DWG.**	**ACTUAL**	**Comment**
Unit Manufacturer				
Model Number				
Serial Number				
CAT Number				
Type				
Motor Manufacturer				
Model Number				
Serial Number				
Belts				
Motor Frame Size				
Motor (HP)				
Voltage per Phase				
Motor Speed (RPM)				
Percentage of Design (%)				
Motor Loading (Amps)				
Percentage of Design (%)				
Starter Manufacturer				
Serial Number				
Volts/Amp/HP				
Fan System Performance				
Air Flow-Fan (L/S)				
Percentage of Design (%)				
Total Static Press (Pa.)				
Percentage of Design (%)				<Picture Here>
Fan Speed (RPM)				
Percentage of Design (%)				
Notes:				

6. Functional Testing Record

Seq. ID[1]	Mode ID[2]	Test Procedure[3] (including special conditions)	Expected Response[4]	Pass Y/N?	Note[5]
1	**TOD check**	The Exhaust fan will run in occupied/unoccupied mode base on sequence of operation and schedule.	Verify that the exhaust fan is running per time of day schedule.		
2	**EAD**	**Interlock to exhaust damper** (if there is an exhaust air damper associated with the fan)	Exhaust fan will be start after damper is confirmed to be open as proven by its end switch.		
3	**OAD**	**Interlock to outdoor air damper** (if there is an outdoor air damper associated with the fan)	Exhaust fan will be start after damper is confirmed to be open as proven by its end switch.		
4	**BAS control**	Command the fan on through BAS;	Please verify that: 1. Exhaust air damper opened, end switch closed the circuit; 2. Outdoor air damper opened, end switch closed the circuit; 3. Fan started; 4. Fan on status was generated on the BAS.		
		Command the fan off through BAS;	Please verify that: 1. Exhaust air damper closed, end switch opened the circuit; 2. Outdoor air damper closed, end switch opened the circuit; 3. Fan stopped; 4. Fan off status was generated on the BAS.		
5	**Alarm**	Shut the fan off on local disconnect while the unit is in normal operation.	Verify that an alarm is generated on the BAS		
6	**Set Point**	Based on the sequence of operation check the zone temperature control if applicable	Check the space temperature based on the room temperature set point.		
7	**Parameter Resume**	**Return all changed control parameters and conditions to their pre-test values[5]**	**Please confirm the system control resumed per design.**		

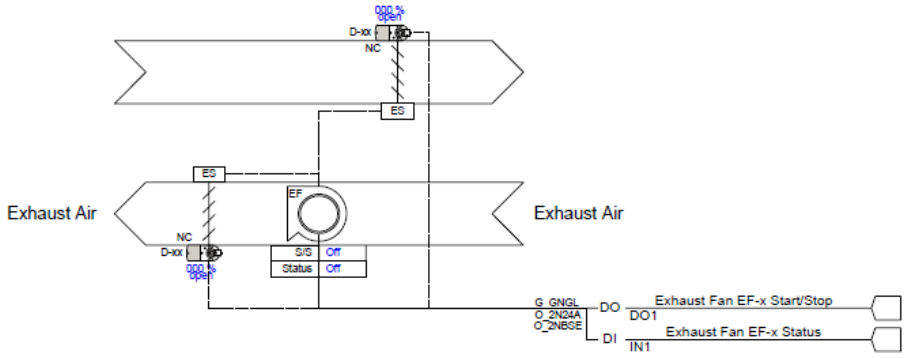
Record Foot Notes
[1]Sequences of operation specified in Contract Documents (attached).
[2]Mode or function ID being tested from testing requirements section of the project Specifications.
[3]Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
[4]Include tolerances for a passing condition.
[5]Record any permanently changed parameter values and submit to Owner.

--END OF TEST—

Sequence of Operation

Control schematic:

Schematics –Typical Exhaust Fan



Maintenance

EXHAUST FAN

PREVENTATIVE MAINTENANCE (MONTHLY)

- Check the general condition of the exhaust/supply fans. Note any damage, excessive temperatures, noise or unusual condition of the fans, motor dampers, ductwork, valves, or associated hardware.
- Check the fan motor casing and ventilation opening for accumulation of dust and debris. Clean if necessary.
- Check all mounting bolts and set screws for security. Check all vibration isolation springs and supports for good condition.
- Check fan belts for wear, damage or misalignment. Adjust or replace as required.
- Check for free movement of all dampers and actuators.
- Replace any burnt out lights.
- Return unit to service and observe during start-up for excessive vibration or belt slippage. Adjust as required.
- Record water meter readings.

PREVENTATIVE MAINTENANCE (SEMI-ANNUAL)

- Check the general condition of the exhaust/supply fans. Note any damage, excessive temperatures, noise or unusual condition of the fans, motor dampers, ductwork, valves, or associated hardware.
- Check the fan motor casing and ventilation opening for accumulation of dust and debris. Clean if necessary.
- Lubricate motor and pillow blocks. Use high pressure lithium grease using a low pressure grease gun until a fresh bean of grease appears at the bearing seals. Rotate the fan slowly by hand while pumping in the grease.
- Check the fan sheaves for alignment and wear. Adjust or replace as necessary.
- Lubricate all dampers, motor shafts and linkages. Check for free movement of shafts and actuators.

Revision History

Date	Revision	Comments
March 18, 2015	DRAFT	Issued for Review and Comments
May 26, 2015	Rev. 1	
May 28, 2015	Rev. 2	Updated construction period

PART 1 - GENERAL

1.1 REFERENCES

.1 National Fire Prevention Association (NFPA)
.1 NFPA 13-2010, Standard for the Installation of Sprinkler Systems.

.2 Underwriter's Laboratories of Canada (ULC)
.1 CAN/ULC S543-09-AM1, Standard for Internal Lug Quick-Connect Couplings for Fire Hose, Includes Amendment 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 data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.2 Submit complete plans to Authority of Jurisdiction for review and approval before commencement of work.
.3 Indicate:
.1 Materials.
.2 Finishes.
.3 Method of anchorage
.4 Number of anchors.
.5 Supports.
.6 Reinforcement.
.7 Assembly details.
.8 Accessories.

.4 Samples:
.1 Submit samples of following:
.1 Each type of sprinkler head.
.2 Signs.

.5 Manufacturers' Instructions:
.1 Provide manufacturer's installation instructions.

1.3 CLOSEOUT SUBMITTALS

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

.2 Manufacturer's Catalog Data, including specific model, type, and size for:
.1 Pipe and fittings.
.2 Alarm valves.
.3 Valves, including gate, check, and globe.
.4 Water motor alarms.
.5 Sprinkler heads.
.6 Pipe hangers and supports.
.7 Pressure or flow switch.
.8 Fire department connections.
.9 Excess pressure pump.
.10 Mechanical couplings.

.3 Drawings:
.1 Sprinkler heads and piping system layout.
.1 Prepare 760 mm by 1050 mm detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".
.2 Show data essential for proper installation of each system.
.3 Show details, plan view, elevations, and sections of systems supply and piping.
.4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.
.2 Electrical wiring diagrams.

.4 Design Data:
.1 Calculations of sprinkler system design.
.2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.

.5 Field Test Reports:
.1 Preliminary tests on piping system.

.6 Records:
.1 As-built drawings of each system.

1.3 CLOSEOUT SUBMITTALS (Cont'd)

.6 (Cont'd)

.1 (Cont'd)

.1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.

.2 Submit 760 mm by 1050 mm drawings on reproducible Mylar film with title block similar to full size contract drawings.

.7 Operation and Maintenance Manuals:

.1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for aboveground and underground piping and other documentation for incorporation into manual in accordance with NFPA 13.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in wet sprinkler systems.

.2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Provide spare sprinklers and tools in accordance with NFPA 13. For secure area sprinkler heads only: increase quantities of spare heads to minimum of 30 of each type.

1.6 DELIVERY, STORAGE AND with HANDLING

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

.2 Delivery and Acceptance Requirements:

1.6 DELIVERY, STORAGE AND HANDLING (Cont'd)

.2 (Cont'd)
.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Storage and Protection:
.1 Store materials indoors in dry location.
.2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

.1 Design system in accordance with NFPA 13 using following parameters:
.1 All areas shall be designed for hazard coverage indicated with design area and associated densities.
.2 Pipe size and layout:
.1 Hydraulic design.
.2 Sprinkler head layout to NFPA 13 or as directed by authorities having jurisdiction and with sprinkler head centred in at least one (1) direction of ceiling tile (where applicable).
.3 The hydraulic design shall be sized to accommodate the higher and most remote zones.
.4 Allow for additional sprinkler heads and pipe distribution to suit all existing interferences.
.5 When sidewall sprinklers listed for light hazard occupancies are used, pipe sizing and spacing shall be according to ordinary hazard rules.
.3 Water supply:

2.1 DESIGN REQUIREMENTS (Cont'd)

.1 (Cont'd)

.3 (Cont'd)

.1 Base design on NFPA 13 and obtain water supply for appropriate fire hydrants from municipality. Conduct flow and pressure test of water supply in vicinity of project to verify municipal data and to obtain criteria for basis of design. Adjust water test values to allow for peak period water usage. Hydraulic calculations shall commence at water main connection at source. Provide as part of hydraulic calculation submission, fire hydrant flow test data and deduct 10% as safety factor based on available pressure value.

.4 Zoning:

.1 System zoning as indicated.

.2 Provide supervised isolating valve and flow switch for each zone and as indicated.

.5 Minimum operating pressure for institutional horizontal sidewall sprinkler-heads shall be 207 kPa to provide maximum horizontal spray discharge.

.2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

.3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings.

.4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.

.5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems. Spacing of sprinkler heads not to exceed that permitted by NFPA 13 for hazard occupancies of areas served.

2.2 ABOVE GROUND PIPING SYSTEMS

.1 Provide fittings for changes in direction of piping and for connections.
.1 Make changes in piping sizes through tapered reducing pipe fittings; bushings will not be permitted.

.2 Perform welding in shop; field welding will be permitted.

.3 Conceal piping in areas with suspended ceiling.

2.3 PIPE, FITTINGS AND VALVES

.1 Pipe:
.1 Ferrous: to NFPA 13. All pipes shall be Schedule 40 wall thickness.

.2 Fittings and joints to NFPA 13:
.1 Ferrous: screwed, welded, flanged or roll grooved.
.1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.
.2 Provide welded or threaded fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.
.3 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.
.4 Rubber gasketted grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 32 mm and larger.
.5 Fittings: ULC approved for use in wet pipe sprinkler systems.
.6 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.
.7 Side outlet tees using rubber gasketted fittings are not permitted.

.3 Valves:
.1 ULC listed for fire protection service.
.2 Gate valves: open by counterclockwise rotation.

2.3 PIPE, FITTINGS AND VALVES (Cont'd)

.3 (Cont'd)

.3 Up to NPS 2: bronze, screwed ends, OS&Y rising stem gate valve.

.4 NPS 2 1/2 and over: cast iron, flanged or roll grooved ends, OS&Y rising stem gate or indicating butterfly type.

.5 Check valves: swing type as above.

.6 Ball drip check valve.

.4 Pipe hangers:

.1 ULC listed for fire protection services.

.5 Sprinkler and standpipe system shall be rated at 1380 kPa.

2.4 SPRINKLER HEADS

.1 Provide sprinklers of current manufacture as indicated in this section.

.2 Sprinklers shall be ULC listed and labelled.

.3 Provide minimum 13 mm nominal diameter discharge orifice.

2.5 UPRIGHT SPRINKLER HEAD

.1 Upright bronze, for hazard coverage as indicated, 5.6 K factor, corrosion resistant coating, chrome finish, fusible link type; 68°C rated, 13 mm orifice.

2.6 CONCEALED SPRINKLER HEAD

.1 Fully concealed pendant, quick response for hazard coverage as indicated, 5.6 K factor, enclosed escutcheon, separate two-piece design of mounting cup and coverplate, internal threaded closure, and 68°C rated, 13 mm adjustment, chrome finish, glass bulb type and polished chrome finish cover.

2.7 PIPE SLEEVES

.1 Provide pipe sleeves where piping passes through walls, floors, and roofs.

.2 Secure sleeves in position and location during construction.

2.7 PIPE SLEEVES (Cont'd)

.3 Provide sleeves of sufficient length to pass through entire thickness of walls, floors, and roofs.

.4 Provide 25 mm minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.
.1 Firmly pack space with mineral wool insulation.
.2 Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to firm but pliable mass.
.3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.

.5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:
.1 Provide cast-iron sleeves.

.6 Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs:
.1 Schedule 40 steel pipe.

2.8 ESCUTCHEON PLATES

.1 Provide one piece type metal plates for piping passing through walls, floors, and ceilings in exposed spaces.

.2 Provide polished chrome in finished spaces.

.3 Provide paint finish on metal plates in unfinished spaces.

2.9 INSPECTOR'S TEST CONNECTION

.1 Locate inspector's test connection at hydraulically most remote part of each system, provide test connections approximately 3 m above floor for each sprinkler system or portion of each sprinkler system equipped with alarm device.

.2 Provide test connection piping to location where discharge will be readily visible and where water may be discharged without property damage.

2.9 INSPECTOR'S TEST CONNECTION (Cont'd)

.3 Provide discharge orifice of same size as corresponding sprinkler orifice.

2.10 SIGNS

.1 Attach properly lettered and approved metal signs to each valve and alarm device to NFPA 13.

.2 Permanently fix hydraulic design data nameplates to riser of each system.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

.2 Test station to be piped to test drain riser.

.3 Install and test equipment to manufacturers' standards.

.4 Coordinate sprinkler head locations with reflected ceiling plans, plumbing, structural, electrical, HVAC plans and existing building systems.

.5 Coordinate sprinkler branch line runs with structural steel, plumbing, electrical and HVAC plans.
.1 Drawings show where mains and branch runs may be installed.

.6 Fill voids around openings through floors and walls for fire protection piping with approved fire stopping and smoke seal.

.7 After completion of sprinkler system, the sprinkler contractor shall furnish a written statement or certificate as per NFPA and to the effect that the work covered by the contract has been completed in accordance with approved tender documents. Provide copies of all test certificates.

3.1 INSTALLATION (Cont'd)

.8 Locate spare parts cabinets as per direction of Departmental Representative.

3.2 PIPE INSTALLATION

.1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.

.2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.

.3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.

.4 Inspect piping before placing into position.

3.3 ELECTRICAL CONNECTIONS

.1 Coordinate with electrical Divisions 26 and 28 the electrical requirement for equipment supplied in this division.

.2 Provide fire alarm system under Section 28 31 00 - Fire Alarm Systems.

.3 Provide control and fire alarm wiring, including connections to fire alarm systems, in accordance with National Electrical Code.

.4 Provide wiring in rigid metal conduit or intermediate metal conduit.

3.4 DISINFECTION

.1 Disinfect new piping and existing piping.

.2 Fill piping systems with solution containing minimum of 50 parts per million of chlorine and allow solution to stand for minimum of 24 hours.

3.4 DISINFECTION (Cont'd)

.3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 part per million or residual chlorine content of domestic water supply.

.4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

3.5 FIELD PAINTING

.1 Refer to Section 09 91 23 - Interior Painting.

3.6 FIELD QUALITY CONTROL

.1 Site Test, Inspection:

.1 Perform test to determine compliance with specified requirements in presence of Departmental Representative and Federal Fire Commissioner.

.2 Test, inspect, and approve piping before covering or concealing.

.3 Preliminary Tests:

.1 Hydrostatically test each system at 200 psi or 50 psi in excess of system working pressure, whichever is greater for a 2 hour period with no leakage or reduction in pressure under supervision of Federal Fire Commissioner.

.2 Flush piping with potable water in accordance with NFPA 13.

.3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.

.4 Test alarms and other devices.

.5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.

.4 Formal Tests and Inspections:

.1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.

3.6 FIELD QUALITY CONTROL (Cont'd)

.1 (Cont'd)

.4 (Cont'd)

.2 Submit written request for formal inspection at least 15 days prior to inspection date.

.3 Repeat required tests as directed.

.4 Correct defects and make additional tests until systems comply with contract requirements.

.5 Furnish appliances, equipment, instruments, connecting devices, and personnel for tests.

.6 Authority of Jurisdiction, will witness formal tests and approve systems before they are accepted.

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 REFERENCES

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME)
.1 ANSI/ASME B16.15-2006, Cast Bronze Threaded Fittings: Classes 125 and 250.
.2 ANSI/ASME B16.18-2001(R2005), Cast Copper Alloy Solder Joint Pressure Fittings.
.3 ANSI/ASME B16.22-2001(R2005), Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.4 ANSI/ASME B16.24-2006, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500 and 2500.

.2 ASTM International Inc. (ASTM)
.1 ASTM A307-10, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
.2 ASTM B88M-05, Standard Specification for Seamless Copper Water Tube (Metric).

.3 American National Standards Institute/American Water Works Association (ANSI/AWWA)
.1 ANSI/AWWA C104/A21.4-08, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings, Includes Erratum (2010).
.2 ANSI/AWWA C110/A21.10-08, Ductile-Iron and Gray-Iron Fittings for Water.
.3 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron and Pressure Pipe and Fittings.
.4 ANSI/AWWA C151/A21.51-09, Ductile-Iron Pipe, Centrifugally Cast.

.4 Canadian Standards Association (CSA International)
.1 CSA B242-05, Groove- and Shoulder-Type Mechanical Pipe Couplings.

.5 Department of Justice Canada (Jus)
.1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

.6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

1.1 REFERENCES (Cont'd)

.7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
.1 MSS SP-67-2002a, Butterfly Valves.
.2 MSS SP-70-2006, Gray Iron Gate Valves, Flanged and Threaded Ends.
.3 MSS SP-71-2005, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
.4 MSS SP-80-2008, Bronze Gate, Globe, Angle and Check Valves.

.8 National Research Council (NRC)/Institute for Research in Construction
.1 NRCC 47668, National Plumbing Code of Canada (NPC) - 2010.

.9 Transport Canada (TC)
.1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

.10 Ontario Plumbing Code, 2006.

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 insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Place materials defined as hazardous or toxic in designated containers.

.2 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

PART 2 - PRODUCTS

2.1 PIPING

.1 Domestic hot, cold, tempered and recirculation systems, within building.
.1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.
.2 Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.

.2 Service water pipe: ductile iron cement mortar lined.
.1 Ductile iron: ANSI/AWWA C151/A21.51.
.2 Cement mortar lining for ductile iron pipe: to ANSI/AWWA C104/A21.4.

2.2 FITTINGS

.1 Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI/ASME B16.24.

.2 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.

.3 Cast copper, solder type: to ANSI/ASME B16.18.

.4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

.5 NPS 3 and larger: mechanical joints or flanged, to ANSI/AWWA C110/A21.10.

2.3 JOINTS

.1 Rubber gaskets, latex-free: to ANSI/AWWA C111/A21.11.

.2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.

.3 Solder: 95/5 tin copper alloy.

.4 Teflon tape: for threaded joints.

.5 Dielectric connections between dissimilar metals: use bronze or brass valve or fittings.

2.3 JOINTS (Cont'd)

.6 For hangers, use tape or copper clamps with copper pipes.

2.4 SWING CHECK VALVES

.1 NPS 2 and under, soldered:
.1 To MSS SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23 - Valves.

.2 NPS 2 and under, screwed:
.1 To MSS SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23 - Valves.

.3 NPS 2-1/2 and over, flanged:
.1 To MSS SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, renewable seat, bronze disc, bolted cap specified Section 23 05 23 - Valves.

2.5 BALL VALVES

.1 NPS 2 and under, screwed:
.1 Class 150.
.2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle as specified Section 23 05 23 - Valves.

.2 NPS 2 and under, soldered:
.1 To ANSI/ASME B16.18, Class 150.
.2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 23 - Valves.

2.6 BUTTERFLY VALVES

.1 NPS 2-1/2 and over, lug:
.1 To MSS SP-67, Class 150.
.2 Cast iron body, ductile iron or bronze disc, stainless steel stem, replaceable EPDM liner and nylon coated ductile iron seat, as specified Section 23 05 23 - Valves.

2.7 CIRCUIT BALANCING VALVES

.1 Sizes: calibrated balancing valves, as specified.

.2 NPS-2 and under:
.1 General:
.1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter.
.2 Accuracy:
.1 Readout to be within plus or minus 2% of actual flow at design flow rate.
.3 Pressure die-cast dezincification resistant copper alloy construction, Teflon disc, screw-in bonnet.
.1 Flow control: At least four (4) full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
.4 Insulation:
.1 Use prefabricated shipping packaging of 5.4 R polyurethane as insulation.
.5 Drain connection:
.1 NPS 3/4 valved and capped, suitable for hose socket.
.2 Incorporated into valve body or provided as separate item.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with NPC, Ontario Plumbing Code and local authority having jurisdiction.

.2 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.

.3 Assemble piping using fittings manufactured to ANSI standards and in accordance with manufacturer's instructions.

.4 Install cold water piping below and away from all hot piping so as to maintain temperature of cold water as low as possible.

3.1 INSTALLATION (Cont'd)

.5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

.6 Buried tubing:
.1 Lay in well compacted washed sand in accordance with AWWA Class B bedding. Where existing ground below bedding is unstable, install pipe on continuous concrete support.
.2 Bend tubing without crimping or constriction. Minimize use of fittings.
.3 Apply one layer of protective coating to all buried ductile iron piping and fittings.

.7 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.

.8 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.

.9 Where piping enters building, provide support and seal against ingress of moisture to approval of authority having jurisdiction.

3.2 VALVES

.1 Isolate equipment, fixtures and branches with ball valves.

.2 Balance recirculation system using circuit balancing valves. Mark settings and record on as-built drawings upon completion.

3.3 PRESSURE TESTS

.1 Conform to requirements of Section 23 05 00 - Common Work Results - Mechanical.

.2 Test pressure: greater of 1-1/2 times maximum system operating pressure or 860 kPa.

3.4 FLUSHING AND CLEANING

.1 Flush entire system for 8 h. Ensure outlets flushed for 2 h. Let stand for 24 h, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean to Provincial potable water guidelines. Let system flush for additional 2 h, then draw off another sample for testing.

3.5 PRE-START-UP INSPECTIONS

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

.2 Verify that system can be completely drained.

.3 Ensure that air chambers, expansion compensators are installed properly.

3.6 DISINFECTION

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

.2 Upon completion, provide laboratory test reports on water quality for Departmental Representative approval.

3.7 START-UP

.1 Timing: Start up after:
.1 Pressure tests have been completed.
.2 Disinfection procedures have been completed.
.3 Certificate of static completion has been issued.
.4 Water treatment systems operational.

.2 Provide continuous supervision during start-up.

.3 Start-up procedures:
.1 Establish circulation and ensure that air is eliminated.
.2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.

3.7 START-UP (Cont'd)

.3 (Cont'd)
.3 Bring domestic hot water storage tank up to design temperature slowly.
.4 Monitor hot water piping systems for freedom of movement, pipe expansion as designed.
.5 Check control, limit, safety devices for normal and safe operation.

.4 Rectify start-up deficiencies.

3.8 PERFORMANCE VERIFICATION

.1 Scheduling:
.1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by authority having jurisdiction.

.2 Procedures:
.1 Verify that flow rate and pressure meet Design Criteria.
.2 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
.3 Sterilize domestic hot water systems for Legionella control.
.4 Verify performance of temperature controls.
.5 Verify compliance with safety and health requirements.
.6 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
.7 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.

.3 Reports:
.1 In accordance with Section 01 91 00 - Commissioning - General Requirements, using report forms as specified.
.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.9 OPERATION REQUIREMENTS

.1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 00 - Common Work Results - Mechanical.

3.10 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM International Inc.
.1 ASTM International (ASTM): ASTM C1053 Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste and Vent (DWV) Applications.
.2 ASTM E438 Standard Specification for Glasses in Laboratory Apparatus.

.2 National Plumbing Code, 2010.

.3 Ontario Plumbing Code, 2006.

.4 Underwriters Laboratories (UL).
.1 UL723 Test for Surface Burning Characteristics for Building Materials.

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

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

PART 2 - PRODUCTS

2.1 PIPING AND

.1 General:

2.1 PIPING AND FITTINGS (Cont'd)

.1 (Cont'd)

.1 Provide a complete acid waste drain and vent system as indicated. This system shall be made of UL Classified borosilicate glass confirming to ASTM specification C1053-90, federal specification DD-g-541 B and military specification MIL-P-22561B(YD).

.2 System shall include all glass straight length traps, compression type tetrafluoroethylene lined couplings, and padded hanger supports. It shall also include protected pipe for under ground burial and recommended adaptor couplings to connect other piping material where applicable.

.3 All pipes shall be installed free of strain, in manner to permit limited movement. Padded pipe hangers shall be used on horizontal runs 200 to 250mm on centers. Vertical risers shall be supported by padded riser clamps designed to restrict lateral and downward movement vertical riser up to 75mm I.D may be supported at evary other floor level.

.2 Above ground sanitary and vent: to CAN/CSA-B70.

.1 Joints.

.1 Hub and spigot.

.1 Caulking lead: to CSA B67.

.2 Mechanical joints.

.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with Ontario Building Code Part 7 Plumbing and local authority having jurisdiction.

.2 Install above ground piping parallel and close to walls and ceilings to conserve headroom and space, and to grade as indicated.

.3 Test the plumbing system in accordance with the O.B.C. Part 7.

3.1 INSTALLATION (Cont'd)

.4 Support of piping to be in accordance with O.B.C. Part 7. Spacing of supports shall not exceed loading for structural systems. Review with core slab manufacturer maximum loadings and increase spacing where required to meet maximum loadings.

.5 All vent piping serving corrosion resistant drainage piping distribution system to be corrosion resistance up to and through the roof penetrations.

.6 Provide fire stopping at drainage piping wall and floor penetrations through fire separations.

.7 Install and test to manufacturer's recommendations.

3.2 TESTING

.1 Hydraulically test to verify grades and freedom from obstructions.

.2 Perform all testing as required by authority having jurisdiction.

3.3 PERFORMANCE VERIFICATION

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

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:
.1 Verify domes are secure.
.2 Verify provisions for movement of roof system.

.4 Ensure that fixtures are properly anchored, connected to system and effectively vented.

3.3 PERFORMANCE VERIFICATION (Cont'd)	.5	Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less). Refer to Section 23 05 53 - Mechanical Identification.
3.4 CLEANING	.1	Clean in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

PART 1 - General

1.1 Reference Standards

.1 All materials and installation shall be in accordance with CSA Standard Z305.1-92, the Technical Standards Safety Authority, CSA Standard B52-M1986, CSA Standard B149.1-00 Natural Gas and Propane Installation Code, NFPA 99 Health Care Facilities and ASTM B819 standard specification for seamless copper tube for medical gas systems.

1.2 Submittals

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

.2 Provide maintenance data for incorporation into manual in accordance with Section 01 33 00 - Submittal Procedures.

1.3 Installation Requirements

.1 Lab gas systems work must be performed only by tradesman familiar with the requirements of CSA Standard Z305.1-92 and CSA Standard B149.1-00, and who are qualified for silver brazing under requirement of the pressure vessels safety branch of the Technical Standards Safety Authority.

.2 Prior to commencing piping work, submit to Consultant for review, a detailed account of the proposed procedures for purging the piping, filling the piping with nitrogen, and maintaining a slight flow of nitrogen with positive pressure in the piping when brazing is being done.

1.3 Installation Requirements (Cont'd)

.3 The Consultant reserves the right to cut out and examine piping joints during the course of the work or after the work is complete. If the interior of the sample piping and/or fittings are found to be contaminated with oxidation or any other material as a result of improper installation, the piping and installation will be considered unacceptable, not in accordance with CSA Standard Z305.1-92, and it shall be the responsibility of the installing subcontractor to replace the joint to the satisfaction of the Departmental Representative. All joints requested to be cut out for testing shall be replaced with all costs being absorbed by the subcontractor.

1.4 System Design

.1 Design Pressures

.1 Lab Air (10 psi)

.1 Maximum system pressure - 60 psi (415kPa).

.2 Minimum pressure at terminal unit-40 psi (275kPa).

.2 Vacuum

.1 Maximum system pressure - 27" Hg (92kPa).

.2 Minimum pressure at terminal unit - 18" Hg (61kPa).

.2 Design temperature

.1 All lab gas services-ambient.

1.5 Co-ordination

.1 Co-ordinate with other contractor providing medical gas equipment and services as identified in Section 01 11 00 - Summary of Work.

PART 2 - PRODUCTS

2.1 General

.1 One manufacturer shall supply the laboratory gas systems equipment specified within this section.

2.2 Lab Gas Piping

.1 Unless noted otherwise, all lab gas piping shall be type 'L' or type 'K' hard temper copper tubing to ASTM B819, factory washed, degreased and supplied to the site with capped ends. Copper tubing shall be complete with factory washed, degreased, cleaned and capped 'silver braze' or equal cast or wrought bronze fittings to ASTM B.61, and brazed joints made with 'sil-fos' or 'sil-fos 5' brazing alloy.

.2 Pipe sizing shall be as per the drawings, however, minimum piping size shall be 12 mm for all services except vacuum which shall have a minimum pipe size of 20mm.

2.3 Lab Gas Piping Shut-Off Valves

.1 Full flow, 1/4 turn on-off ball type valves, 600 psig WOG (4137kPa) rated, factory cleaned, lubricated and pressure tested, in-line serviceable and complete with a bronze body, lever handle, bronze ball, Vilton Seals with Teflon (TFE) seat, O-ring packing, blowout-proof system, type 'K' hard copper washed and capped extensions, and colour coded permanent gas identification labels. Butterfly type shut off valves are acceptable on vacuum piping of size 65mm and larger.

2.4 Lab Gas Check Valves

.1 Shall be straight through check valves 400 psig WOG rated, factory cleaned, individually packaged and capped. Bronze body, vibration free fast acting for silent operation, positive shut-off with self-aligning spring loaded plunger and mate with a soft seat.

2.5 Hose Cocks

.1 Splash-mounted double valve units c/w serrated hose sleeves for vacuum and compressed air. Locations as shown on drawings.

PART 3 - EXECUTION

3.1 Lab Gas System Piping Installation

.1 Prior to installation of lab gas piping system, make all arrangements and pay all fees to register and have the medical gas piping system inspected by the Technical Standards and Safety Authority.

.2 Where located in a combustible partition, pipe shall be type 'K' hard copper as above but installed within a continuous length of rigid galvanized steel conduit with spacers top and bottom to prevent direct contact of the copper pipe and the steel pipe, and the galvanized steel pipe shall be identified as to its purpose.

.3 Prior to brazing operations, except for final brazed joint connections to equipment, purge the piping with oil free dry nitrogen as required to remove all air and oxygen, and maintain a small purge flow of nitrogen during brazing to prevent re-entry of air or oxygen into the piping until brazing work is complete. Do all piping work in accordance with specific requirements of CSA Z305.1-92.

.4 Ensure that all tools used during erection of the piping systems are clean and kept free of oil and grease.

.5 Ensure that each piece of piping installed is free of obstructions and debris by 'looking down the pipe' prior to hanging it. Failure to do same will result in rejection of the work and all costs associated with its replacement shall be borne by the contractor.

.6 Clean piping work which has become contaminated during construction in accordance with cleaning procedures outlined in CSA Standard Z305.1-92.

.7 Completely identify all piping system work, concealed and exposed in accordance with requirements of CSA Standard Z305,1-92, including background colour, lettering and form.

3.1 Lab Gas System Piping Installation (Cont'd)

.8 Provide shut-off valves in piping where shown.

.9 Provide piping connections to outlets integral with ceiling mounted or wall mounted isolated power centre master and slave service columns or panels.

.10 Provide capped connections in piping where shown. Equip each capped connection with a shut-off valve and a threaded plug or cap.

.11 Make arrangements with the Department of Labour to witness medical gas system tests as the work progresses and prior to concealment.

.12 Test lab gas system and components in accordance with CSA standard Z305.1-92.

3.2 Lab Gas System Certification

.1 When lab gas system work is complete, including plant performance and acceptance testing and commissioning, notify the Consultant that the systems are ready for certification.

.2 Certification will be performed by an independent testing agency meeting requirements of C.S.A. Standard CAN/CSA Z305.1-92 who will be retained and paid directly by the Owner. Certification will be performed in the presence of an inspecting team comprising the testing agency, a member of your personnel, and a Health Canada representative familiar with lab gas systems.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Related Sections:
.1 Section 01 91 00 - Commissioning - General Requirements.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM).
.1 ASTM A126-04(2009), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
.2 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.2 American Water Works Association (AWWA).
.1 ANSI/AWWA C700-09, AWWA Standard for Cold-Water Meters -- Displacement Type, Bronze Main Case, Includes Erratum.
.2 ANSI/AWWA C701-07, Cold-Water Meters, Turbine Type, for Customer Service.
.3 ANSI/AWWA C702-10, Cold-Water Meters-Compound Type.

.3 Canadian Standards Association (CSA International).
.1 CAN/CSA B64 Series-07, Backflow Preventers and Vacuum Breakers (Consists of B64.0, B64.1.1, B64.1.2, B64.1.3, B64.2, B64.2.1, B64.2.1.1, B64.2.2, B64.3, B64.3.1, B64.4, B64.4.1, B64.5, B64.5.1, B64.6, B64.6.1, B64.7, B64.8 and B64.9), Includes Update No. 1 (2008).
.2 CSA B79-08, Commercial and Residential Drains and Cleanouts.
.3 CSA B356-10, Water Pressure Reducing Valves for Domestic Water Supply Systems.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
.1 Material Safety Data Sheets (MSDS).

.5 Plumbing and Drainage Institute (PDI).
.1 PDI-WH201-10, Water Hammer Arresters Standard.

.6 Ontario Plumbing Code, 2006.

1.2 REFERENCES (Cont'd)

.7 National Plumbing Code, 2010.

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 for fixtures and equipment.
.2 Indicate dimensions, construction details and materials for specified items.
.3 Submit WHMIS MSDS. Indicate VOC's for adhesive and solvents during application and curing.

.3 Shop Drawings:
.1 Submit shop drawings to indicate materials, finishes, method of anchorage, number of anchors, dimensions construction and assembly details and accessories for specified items.

.4 Instructions: submit manufacturer's installation instructions.

.5 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals, include:
.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
.2 Details of operation, servicing and maintenance.
.3 Recommended spare parts list.

1.4 QUALITY ASSURANCE

.1 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

PART 2 - PRODUCTS

2.1 CLEANOUTS

.1 Access covers:

.1 Floor access: round cast iron body and frame with adjustable secured heavy duty nickel bronze top and:

.1 Plugs: bolted bronze with neoprene gasket.

.2 Cover for all floor types: nickel bronze heavy duty round 12 mm thick scoriated cover, gasket, vandal-proof screws. Fasteners to be stainless steel Torx with pin style.

2.2 WATER HAMMER ARRESTORS

.1 Stainless steel, heavy duty bellows type, bottom pipe threads with nesting bellows contained in stainless steel casing with sufficient volume to dissipate kinetic energy from water shock. Approved by PDI to Standard WH201.

2.3 TRAP SEAL PRIMERS

.1 Install for all floor drains and elsewhere, as indicated.

.2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Consultant.

.3 Install soft copper tubing to floor drain.

2.4 FLOOR DRAIN

.1 Floor drain: to B79-08.

.2 FD-1: Medium duty: stainless steel body round adjustable head, 5" (125mm) dia. Stainless steel strainer, integral seepage pan, trap priming connection and clamping collar.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with National Plumbing Code of Canada, Ontario Plumbing Code, and local authority having jurisdiction.

.2 Install in accordance with manufacturer's instructions and as specified.

3.2 CLEANOUTS

.1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required by code, and as indicated.

.2 Bring cleanouts to wall or finished floor unless serviceable from below floor.

.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

.4 Cleanouts installed in y-chases shall be set above flood level of adjacent water closets.

3.3 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures where indicated.

3.4 START-UP

.1 General:
.1 In accordance with Section 01 91 00: Commissioning - General Requirements, supplemented as specified herein.

.2 Timing: start-up only after:
.1 Pressure tests have been completed.
.2 Disinfection procedures have been completed.
.3 Certificate of static completion has been issued.
.4 Water treatment systems operational.

.3 Provide continuous supervision during start-up.

3.5 TESTING AND ADJUSTING

.1 General:
.1 In accordance with Section 01 91 00 - Commissioning - General Requirements, supplemented as specified.

.2 Timing:
.1 After start-up deficiencies rectified.
.2 After certificate of completion has been issued by authority having jurisdiction.

.3 Application tolerances:
.1 Pressure at fixtures: +/- 70 kPa.
.2 Flow rate at fixtures: +/- 20%.

.4 Adjustments:
.1 Verify that flow rate and pressure meet design criteria.
.2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

.5 Access doors:
.1 Verify size and location relative to items to be accessed.

.6 Cleanouts:
.1 Verify covers are gas-tight, secure, yet readily removable.

.7 Water hammer arrestors:
.1 Verify proper installation of correct type of water hammer arrestor.

.8 Commissioning Reports:
.1 In accordance with Section 01 91 00 - Commissioning - General Requirements.

.9 Training:
.1 In accordance with Section 01 91 00 - Commissioning - General Requirements.
.2 Demonstrate full compliance with Design Criteria.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CAN/CSA B45 Series-02(R2008), Plumbing Fixtures (Consists of B45.0-02, B45.1-02, B45.2-02, B45.3-02, B45.4-02, B45.5-02, B45.6-02, B45.7-02, B45.8-02 and B45.9-02), Includes Updates No. 1, No. 2, No. 3, and No. 4 (2007).
.2 CSA B125.3-05, Plumbing Fittings.
.3 CSA B651-04(R2010), Accessible Design for the Built Environment, Includes Update No.1 (2007).

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.

1.3 CLOSEOUT SUBMITTALS

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

.2 Include:
.1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
.2 Details of operation, servicing, maintenance.
.3 List of recommended spare parts.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CSA B125.3.

.3 Exposed plumbing brass to be chrome plated.

.4 Number, locations: architectural drawings to govern.

.5 Fixtures to be product of one manufacturer.

.6 Trim to be product of one manufacturer.

.7 Sinks:

.1 S-1: single bowl with right drainboard.

.1 Sink: 316 stainless steel, 16 gauge drainboard, 18 gauge bowl, exposed surfaces finished to a satin finish, 18-8 stainless steel, 40mm waste assembly included. Outside dimension: 107cm x 53cm. Bowl dimension: 18cm x 16cm x 18cm deep.

.2 Faucet: Below deckmount sink faucet, 203mm centres, two handle, polished chrome plated finish trim, cast brass bodies, brass swing spout, laminar flow, 102mm blade handles on 203mm centres.

.2 S-2: single bowl with left drainboard.

.1 Sink: 316 stainless steel, 16 gauge drainboard, 18 gauge bowl, exposed surfaces finished to a satin finish, 18-8 stainless steel, 40mm waste assembly included. Outside dimension: 107cm x 53cm. Bowl dimension: 18cm x 16cm x 18cm deep.

.2 Faucet: Below deckmount sink faucet, 203mm centres, two handle, polished chrome plated finish trim, cast brass bodies, brass swing spout, laminar flow, 102mm blade handles on 203mm centres.

.3 S-3: single bowl with left and drainboard and RO faucet.

2.1 MANUFACTURED UNITS (Cont'd)

.7 (Cont'd)
.3 (Cont'd)
.1 Sink: 316 stainless steel, 16 gauge drainboard, 18 gauge bowl, exposed surfaces finished to a satin finish, 18-8 stainless steel, 40mm waste assembly included. Outside dimension: 107cm x 53cm. Bowl dimension: 18cm x 16cm x 18cm deep.
.2 Faucet: Below deckmount sink faucet, 203mm centres, two handle, polished chrome plated finish trim, cast brass bodies, brass swing spout, laminar flow, 102mm blade handles on 203mm centres.
.3 RO water faucet: heavy duty brass pipe with inert lining tygon tubing, 152mm radius gooseneck, self-closing and lock-open control valves.

.8 Emergency Eyewashes:
.1 EEW-1:
.1 Sink or deck-mounted, right-sided, antimicrobialy treated stainless steel Axion MSR eye/face wash head.
.2 Inverted directional laminar flow eye/face wash which achieves zero vertical velocity.
.3 Integral 3.7 gpm flow control, chrome plated brass stay-open ball valve.
.4 Stainless steel ball and stem, swing away feature when not in use.
.5 Universal sign.
.6 NPS ½ OD slip joint inlet.
.7 Equipped with plastic pop-off dust cover for eyewash head.
.8 CSA certified to meet ANSI Z358.1-2009.
.9 Standard of Acceptance: Haws 7612.
.10 Tempered Water Blending System:
.1 Standard of Acceptance: Hans 920/EFE.
.2 Provide check valves on both hot and cold water upstream of water tempering valve.
.2 EEW-2:
.1 Sink or deck-mounted, left-sided, antimicrobialy treated stainless steel Axion MSR eye/face wash head.

2.1 MANUFACTURED UNITS (Cont'd)

.8 (Cont'd)
.2 (Cont'd)
.2 Inverted directional laminar flow eye/face wash which achieves zero vertical velocity.
.3 Integral 3.7 gpm flow control, chrome plated brass stay-open ball valve.
.4 Stainless steel ball and stem, swing away feature when not in use.
.5 Universal sign.
.6 NPS ½ OD slip joint inlet.
.7 Equipped with plastic pop-off dust cover for eyewash head.
.8 CSA certified to meet ANSI Z358.1-2009.
.9 Standard of Acceptance: Haws 7612.
.10 Tempered Water Blending System:
.1 Standard of Acceptance: Hans 920/EFE.
.2 Provide check valves on both hot and cold water upstream of water tempering valve.

.9 Fixture Piping:
.1 Water supplies:
.1 Fully concealed, rigid copper supply pipes with screw driver stops. Where supply is located in Y-chase, use quarter turn bronze ball valve.
.2 Waste:
.1 Fully concealed, brass p-trap with cleanout on each fixture not having integral trap or cleanout.

.10 Emergency Shower:
.1 ES-1:
.1 Flush to ceiling mounted drench shower, 10½" polished stainless steel shower head and stay-open ball valve that is activated by a pull rod.
.2 Standard of Acceptance: Haws Model 8169.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Mounting heights:
.1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.
.2 Barrier-free: to comply with most stringent of either NBCC or CSA B651.

3.2 ADJUSTING

.1 Conform to water conservation requirements specified in this section.

.2 Adjustments:
.1 Adjust water flow rate to design flow rates.
.2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Checks:
.1 Aerators: operation, cleanliness.
.2 Vacuum breakers, backflow preventers: operation under all conditions.
.3 Review all secure fixtures to confirm no exposed non-secure fasteners or gaps or open seams.

.4 Thermostatic controls:
.1 Verify temperature settings, operation of control, limit and safety controls.

3.3 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 RELATED SECTIONS

.1 Section 01 51 00 - Temporary Utilities.

1.2 USE OF SYSTEMS

.1 Use of new and existing permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted only under the following conditions:.
.1 Entire system is complete, pressure tested, cleaned, flushed out.
.2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
.3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
.4 There is no possibility of damage from any cause.
.5 Supply ventilation systems are protected by 60% filters, which shall be inspected daily, changed every week or more frequently as required.
.6 Return systems have approved filters over all openings, inlets, outlets.
.7 All systems will be:
.1 operated as per manufacturer's recommendations or instructions.
.2 operated by Contractor.
.3 monitored continuously by Contractor.
.8 Warranties and guarantees are not thereby relaxed.
.9 Regular preventive and all other manufacturers recommended maintenance routines are performed by Contractor at his own expense and under supervision of Departmental Representative.
.10 Before static completion, entire system to be refurbished, cleaned internally and externally, restored to "as- new" condition, filters in air systems replaced.

.2 Filters referred to herein are over and above those specified elsewhere in this specification.

1.2 USE OF SYSTEMS (Cont'd)

.3 Exhaust systems are not included in any approvals for temporary heating ventilation.

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 Section 09 91 23 - Interior Painting.

.2 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 GENERAL

.1 This section covers items common to all sections of Division 21, 22, 23 and 25.

.2 Obtain and pay for all required permits and approvals.

.3 It is the intent of the specification that there be one prime contractor for all of the Division 21, 22 and 23 work. The prime mechanical contractor shall be responsible for all Division 21, 22, 23 and 25 subtrades. The prime mechanical contractor shall be responsible for overall co-ordination and commissioning of systems. The prime mechanical contractor shall be identified at the start of construction.

1.3 WORK SEQUENCE

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

.2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.

.3 Required stages:
.1 Phase 1 - Rooms 115, 164, and clean rooms on Level 3.
.2 Phase 2 - Room 165.
.3 Phase 3 - Room 225.
.4 Each phase shall be completed, commissioned and fully operational, prior to start of the next phase.
.5 Contractor will need to mobilize and demobilize during each phase of the fiscal year.

.4 Maintain fire access/control.

1.4 EQUIPMENT LIST

.1 Complete list of equipment and materials to be used on this project and forming part of bid documents by adding manufacturer's name, model number and details of materials, and submit for approval.

.2 Submit for approval at time of bid within 48 hours within 10 days after award of contract.

1.5 TRIAL USAGE

.1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Protect work against loss or damage until accepted by Departmental Representative.

.3 Obtain written permission from the Departmental Representative to use permanent equipment and systems, prior to acceptance by the Departmental Representative, including testing.

.4 Departmental Representative may use equipment and systems for test purposes or for continuity of operation prior to acceptance.

.5 Protect equipment and system openings from dirt, dust and other foreign materials during temporary usage.

.6 Supply labour, material and instruments required for testing.

.7 Clean and renew equipment and systems, used prior to acceptance, to their original new state and full working condition.

.8 Guarantee period and commencement date shall not be affected by temporary usage.

.9 Trial usage to apply to following equipment and systems:

.1 HVAC Systems:

.1 Ventilation Systems:

.1 Fume valves.

1.5 TRIAL USAGE (Cont'd)

.9 (Cont'd)
.1 (Cont'd)
.2 Lab pressure controls.
.2 Heating Systems:
.1 Radiant heating.
.2 Plumbing Systems:
.1 Water tempering systems.
.2 Backflow prevention.
.3 Controls Systems:
.1 BACS building HVAC control and monitoring system.
.2 BACS interface.

1.6 PROTECTION OF OPENINGS

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

1.7 PAINTING

.1 To Section 09 91 23 - Interior Painting.

.2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

.3 Prime and touch up marred finished paintwork to match original.

.4 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

.5 Finish painting will be provided under. Architectural section.

.6 Hangers, supports and equipment fabricated from ferrous metals shall be given at least one coat of corrosion resistant primer paint before shipment to job site.

.7 Touch-up damaged surfaces of all mechanical equipment and materials, to the satisfaction of Departmental Representative. Use primer or enamel to match original. Do not paint over nameplates.

1.8 SPARE PARTS

.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 set of belts for each piece of machinery.
.4 One glass for each gauge glass.
.5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

1.9 SPECIAL TOOLS

.1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

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

1.10 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS

.1 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.

.2 Where specified elsewhere in Mechanical Divisions, manufacturers to provide demonstrations and instructions.

.3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Where deemed necessary, Departmental Representative may record these demonstrations on video tape for future reference.

1.11 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 to be approved by, and final copies deposited with, Departmental Representative before final inspection.

.3 Operation data to include:
.1 Control schematics for each system including environmental controls.
.2 Description of each system and its controls.
.3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
.4 Operation instruction for each system and each 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 shall 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 data sheets with point of operation as left after commissioning is complete.
.2 Equipment performance verification test results.
.3 Special performance data as specified elsewhere.
.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.6 Approvals:
.1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless so directed by Departmental Representative.
.2 Make changes as required and re-submit as directed by Departmental Representative.

1.11 CLOSEOUT SUBMITTALS (Cont'd)

.7 Additional data:
.1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.12 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Shop drawings and product data shall show:
.1 Mounting arrangements.
.2 Operating and maintenance clearances. (eg. access door swing spaces.)

.3 Make, model and nameplate data for each piece of equipment.

.4 Size and capacity of each piece of equipment.

.5 Electrical characteristics.

.6 Shop drawings and product data shall be 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 as to current model production.
.5 Certification of compliance to applicable codes.

.7 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: buse MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

.8 Shop drawings shall be submitted by specification section. Do not combine more than one section into one submission.

1.12 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.9 Shop drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each shop drawing shall give the identifying number of the specific pump, fan, etc. for which it was prepared (e.g. fan F-7).

.10 Each shop drawing for non-catalogue items shall be prepared specifically for this project. Shop drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.

.11 Each shop drawing or catalogue sheet shall be stamped and signed by the contractor to indicate that he has checked the drawing for conformance with all requirements of the drawings and specifications, that he has co-ordinated this equipment with other equipment to which it is attached and/or connected and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that electrical co-ordination is complete before submitting drawings for review.

.12 Installation of any equipment shall not start until after final review of shop drawings by the Departmental Representative has been obtained.

.13 When requested, shop drawings shall be supplemented by data explaining the theory of operation - for example: as variable speed motor control - the Departmental Representative may also request that this information be added to the maintenance and operating manual.

.14 Provide a lead sheet with the project name, issue date, issue number, specification section number, title of section and with space for shop drawing review stamps for the Contractor and Departmental Representative.

1.12 SHOP DRAWINGS AND PRODUCT DATA (Cont'd)

.15 The Contractor shall make notations with respect to the following aspects and any other deviations from the contract documents:
.1 Deviation from specified performance, electrical requirements and equipment specified.
.2 Changes in dimensions from equipment indicated or specified, including confirmation that equipment will fit into space allotted. Contractor shall provide written notation how deviations are being addressed and what co-ordination with other affected trades has been or will be undertaken.

.16 Departmental Representative's review of shop drawings is for general conformance only, and does not relieve the contractor from meeting all aspects of specification. The contractor is solely responsible for the completeness, correctness, and all information presented on shop drawings. There shall be no additional cost to Owner for failure of the contractor to complete a thorough review of shop drawings for compliance. The contractor shall not assume consultant has performed a thorough review and the contractor shall be ultimately responsible for completeness of shop drawings and the equipment conformance with specifications.

.17 One (1) copy of each shop drawing must be included in the operation and maintenance manual.

.18 Any equipment data, requested calculations, written certifications or other similar information specified or shown on the Drawings shall be included with shop drawing submittals.

.19 Shop drawings shall be submitted in order of delivery requirements, ie, all items that have long delivery times, or any item that is to be installed first, must be submitted first. The Contractor shall allow for consultant shop drawing review times in their schedule.

1.13 CLEANING

.1 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

.2 Clean interior and exterior of all new systems including strainers. Vacuum interior of ductwork and air handling units.

.3 Upon completion remove temporary protection. Remove stains and smudges from paint work. Wash and polish plumbing fixtures.

.4 Replace broken, damaged or scratched fixtures.

1.14 CO-ORDINATION DRAWINGS

.1 Provide co-ordination drawings for review by Departmental Representative prior to installation of conduit, piping, ductwork, etc. as specified in Division 21, 22, 23 and 25. Three (3) copies of such drawings shall be submitted for review, of which one (1) will be retained by the Departmental Representative.

.2 Co-ordination drawings, OR fabrication drawings are required in all cases where in the Departmental Representative's opinion, interference between the various trades render such drawings necessary.

.3 Co-ordination and installation drawings will consist of dimensioned and scaled drawings showing locations of apparatus, ducts, piping, valves and all other accessories with all necessary sections and details. The drawings will be complete with dimensions of piping and conduits, locations of sleeves, openings, supports and anchors as well as all pertinent information concerning structural architectural and electrical works.

.4 Drawings will be produced utilizing a computer aided drafting system on existing building component drawings.

1.14 CO-ORDINATION DRAWINGS (Cont'd)

.5 Collaborate fully with all other Trades in order to determine the location of their respective work, thus avoiding any possible interference.

.6 Installation drawings shall be required:
.1 For the location of sleeves, openings and holes to be provided in walls, floors, beams, and columns.
.2 For the anchors.
.3 For all work pertaining to automatic sprinklers and fire protection.
.4 For all ventilation work.
.5 For all supports in ventilation shafts.
.6 For all mechanical work in equipment rooms, shafts, main and secondary electrical rooms.
.7 For all mechanical rooms where space is limited.
.8 Also wherever Departmental Representative deems necessary.
.9 For all automatic sprinkler work, the co-ordination drawings will be the responsibility of the sprinkler contractor.

.7 The design of the structural framing of the mechanical equipment and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit drawings for review to the Departmental Representative showing the layout and weights of all finally selected mechanical equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure. Structural design has been based on equipment listed by model number. Alternate equipment shall not exceed weight and dimensions of equipment listed without prior approval of Departmental Representative. If alternate equipment is not approved by Departmental Representative, Contractor shall supply equipment listed at no additional cost to Project. If alternate equipment is selected, Contractor shall provide all structural revisions necessary and pay all cost including engineering.

1.14 CO-ORDINATION DRAWINGS (Cont'd)

.8 Pump capacities, control valve sizing, etc., have been based on equipment specified. Upon submission of shop drawings, contractor shall review with Departmental Representative all design and equipment changes and where required to accommodate design or equipment changes contractor shall engineer and revise equipment capacities as required. There shall be no extra cost to Project for changes to equipment to accommodate changes discussed above. No installations shall proceed until this co-ordination has been completed.

1.15 AS-BUILT DRAWINGS

.1 Site records:

.1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark there on all changes as work progresses and as changes occur. This shall include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection at all times.

.2 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing (TAB), 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 Departmental Representative for approval and make corrections as directed.

.4 TAB to be performed using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

1.15 AS-BUILT DRAWINGS (Cont'd)

.3 Submit copies of as-built drawings for inclusion in final TAB report.

1.16 HALOCARBONS

.1 Comply with Federal Halocarbon Regulations 2003 under the Canadian Environmental Protection Act 1999, EPAM and PWGSC Ontario Region Halocarbon Information Sheet dated March 2010.

1.17 EQUIPMENT REQUIREMENTS AND INSTALLATIONS

.1 Unions or flanges: provide for ease of maintenance and disassembly.

.2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.

.3 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

.4 Provide new materials and equipment of proven design, quality and of current models with published ratings for which replacement parts are readily available. Materials and equipment must be free from blemishes, oxidation, damage, etc.

.5 The following definitions shall apply to all sections and drawings of Division 21, 22, 23 and 25.
.1 "CONCEALED" - mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
.2 "EXPOSED" - will mean "not concealed" as defined herein (eg. mechanical rooms).
.3 "PROVIDE" - will mean supply, installation and connection.

.6 Uniformity:
.1 Use product of one manufacturer unless otherwise specified, for equipment or material of the same type of classification.
.2 Installation:

1.17 EQUIPMENT REQUIREMENTS AND INSTALLATIONS (Cont'd)

.6 (Cont'd)

.2 (Cont'd)

.1 Unless otherwise specified, follow manufacturer's recommendations for safety, adequate access for inspection, maintenance and repairs.

.2 Permit equipment maintenance and disassembly with minimum disturbance to connecting piping and duct systems without interference with building structure or other equipment.

.3 Lubrication:

.1 Provide accessible lubricating means for bearings, including permanent lubrication "Lifetime" bearings.

.7 Provide and install all necessary vibration control components.

.8 Equipment drains: pipe to floor drains or funnel floor drains.

.9 Provide and install all backflow preventors necessary to protect the potable water system.

1.18 ANCHOR BOLTS AND TEMPLATES

.1 Provide, locate and set all anchor bolts and fastening devices and equipment.

1.19 ELECTRICAL

.1 Electrical work to conform to Divisions 26, 27 and 28 including the following.

.2 Provide all controls, disconnects, magnetic starters, transformers, relays, wiring and panels for all motors and devices for packaged equipment as indicated in various specification sections.

.3 Electrical equipment shall bear CSA labels and/or ULC approvals to comply with local power utility's requirements. Conform to the requirements of the Canadian Electrical Code, National Building Code, local, municipal and provincial authorities.

1.19 ELECTRICAL (Cont'd)

.4 Control panels to be complete with barriered numbered terminal strip for interconnecting of conductors between master control panel and remote control panel and associated equipment.

.5 Controls

.1 All power and control wiring, relays, transformers and wiring related to motorized dampers, thermostats, controllers, sensors, control panels, control devices, valves, pressure and limit switches, etc., which are related to control systems to be provided by Division 23, unless specifically indicated otherwise.

.2 All wiring to be run in conduit.

.3 Control wiring to be copper conductor type RW 90 (XLPE); minimum #14 AWG for power circuits and minimum #18 AWG for control only.

.4 Conduit to be E.M.T. minimum 20 mm complete with compression couplings. Provide ground conductor in all conduit runs.

.5 Use liquid tight flexible conduit for final connection to motorized dampers and vibrating equipment.

.6 Ensure that electrical contractor has provided for auxiliary contacts for the building control systems.

.7 Coordinate wiring point terminations for the BACS with Division 25.

1.20 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

.3 Motors under 373 W (½ HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.

1.20 MOTORS (Cont'd)

.4 Motors 373 W (½ HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 575 V, unless otherwise specified or indicated.

.5 Motor controllers and all electrical wiring unless otherwise shown shall be provided under Electrical Division. Electrical items integrated with the mechanical systems (motorized valve, motorized dampers, temperature, and pressure devices, etc.) are provided by Division 25. Factory installed wiring and equipment in packaged units to be compatible with external control power; and connecting terminals shall be clearly identified.

.6 Polyphase motors shall be squirrel cage induction of CEMA Design B for fans and pumps.

.7 Where motor type, power, speed or other essential data are not specified, obtain this information from the manufacturer of the equipment and have it approved before ordering motors.

.8 CEMA standards shall be taken as minimum requirements for motor design and performance.

.9 All motors shall be CEMA open-drip-proof unless specified otherwise.

.10 All motors shall be specially selected for quiet operation and high efficiency and compatible with variable speed drives (where applicable).

.11 Motors shall be rated for continuous duty and full load. The maximum rise in temperature shall not exceed 40°C for open-drip-proof and 55°C for totally enclosed.

.12 Motors shall be capable of withstanding momentary overloads of 50% without injurious overheating.

1.20 MOTORS (Cont'd)

.13 Motors for belt drive shall have adjustable bases with set screws to maintain belt tensions. Motors for direct drive shall be dowelled at base plate at two points.

.14 Motor shall have legible nameplates giving manufacturer's name, shop number, watts, rpm, current characteristics.

.15 Motor enclosures: suitable for service and location specified in project. Obtain information from manufacturer and have it approved before ordering.

.16 Terminal box: coordinate dimensions and locations with Electrical Work. Locate box clear of motor ventilation opening.

.17 All motors 18.75 kW (25 HP) and above shall be supplied with integral thermistor protection.

1.21 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 specified.

.3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5 kW (10 HP)and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 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.

1.21 BELT DRIVES (Cont'd)

.7 Provide one complete set of spare belts for every drive supplied under this Contract.

1.22 GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives:
.1 Expanded metal screen welded to steel frame.
.2 Minimum 1.3 mm thick sheet metal tops and bottoms.
.3 40 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 1.5 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, 20 mm mesh.
.2 Net free area of guard: not less than 80% of fan openings.
.3 Securely fasten in place.
.4 Removable for servicing.

.7 Guards to meet safety requirements of Provincial Ministry of Labour and local authorities have jurisdiction.

1.23 EQUIPMENT SUPPORTS

.1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Div. 21, 22, 23 and 25.

.2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of Div. 05. Submit structural calculations with shop drawings.

1.23 EQUIPMENT SUPPORTS (Cont'd)

.3 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm high and 50 mm larger than equipment dimensions all around. Housekeeping pads shall be the responsibility of the General Contractor.

.4 Provide all necessary mechanical equipment vibration control, specified or recommended by the equipment manufacturer.

1.24 SLEEVES

.1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated.

.2 Schedule 40 steel pipe.

.3 Cast iron sleeves or steel sleeves with annular fin continuously welded at midpoint:
.1 Through foundation walls.
.2 Where sleeve extends above finished floor.

.4 Sizes: minimum 6 mm clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm above other floors. For equipment room floors, terminate 100 mm above floor and provide concrete curb.

.6 Fill voids around pipes:
.1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
.2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
.3 Ensure no contact between copper tube or pipe and ferrous sleeve.
.4 Fill future-use sleeves with lime plaster or other easily removable filler.

1.24 SLEEVES (Cont'd)

.6 (Cont'd)

.5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CAN/CGSB-1.181-99.

.7 Sleeves are to be furnished and set under this division. Coordinate and provide supervision during all concrete pouring operations.

.8 Make disposable wood sleeves for rectangular ducts passing through concrete block or poured concrete floors or walls. Sleeves for round ducts to be preformed black iron with reinforcing braces or capped to maintain shape and with mounting lugs. Where ducts pass through equipment room floors, provide 100 mm high concrete curb around duct allowing adequate space for fire damper sleeve and room for expansion. Concrete curbs shall be by Division 23.

.9 Where pipe motion due to expansion and contraction will occur, make sleeves of sufficent diameter to permit free movement of the pipe. Where pipe or ducts are insulated, make sleeve of sufficient diameter to pass pipe insulation. Check floor and wall construction and finish to determine proper lengths or sleeves for various locations; make actual length to suit the following: to match the thickness of the finished surface of the slab or partition for wet areas to extend 50 mm above finished surface (i.e.: mechanical/electrical service areas, washrooms, pipe chases, etc.).

.10 All sleeves shall have all voids filled between metal sleeve material and pipe, conduit or duct passing through. The procedure for sleeve caulking shall be as follows:

.1 For insulated ducts and pipes passing through sleeves, the space between the insulation and sleeve shall be caulked and each side sealed with a non-hardening mastic.

.2 Non-insulated pipes and ducts shall be caulked as above.

1.24 SLEEVES (Cont'd)

.11 This Division shall prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slab/decks and walls for piping, ductwork, and equipment. In case of failure to provide information in time (ie. before the concrete is poured) any extras incurred shall be at the expense of this Division.

1.25 PREPARATION FOR FIRESTOPPING

.1 Refer to Section 07 84 00 - Fire Stopping.

.2 Firestopping material and installation within annular space between pipes, ducts, insulation and adjacent fire separation.

.3 Uninsulated unheated pipes not subject to movement: no special preparation.

.4 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe to move without damaging firestopping material.

.5 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.

1.26 ESCUTCHEONS

.1 On pipes passing through walls, partitions, floors and ceilings in finished areas.

.2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.

.3 Outside diameter to cover opening or sleeve.

.4 Inside diameter to fit around finished pipe.

.5 Do not use split-type escutcheon plates.

.6 Secure to pipe on finished surfaces but not insulation.

1.27 TESTS

.1 Give 72 hours written notice of date for tests.

.2 Insulate or conceal work only after testing and approval by Departmental Representative.

.3 Conduct tests in presence of Departmental Representative.

.4 Bear costs including retesting and making good.

.5 Piping:
.1 General: maintain test pressure without loss for 4 h unless otherwise specified.
.2 Hydraulically test steam and hydronic piping systems at 1-1/2 times system operating pressure or minimum 862 kPa, whichever is greater.
.3 Test drainage, waste and vent piping to Ontario Building Code and authorities having jurisdiction.
.4 Test domestic hot, cold and recirculation water piping at 1-1/2 times system operating pressure or minimum 862 kPa, whichever is greater.
.5 Test fire systems in accordance with NFPA and authorities having jurisdiction and as specified elsewhere.

.6 Test natural gas systems to CSA B149.1-10 and requirements of authorities having jurisdiction.

.7 Equipment: test as specified in relevant sections.

.8 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

.9 Provide written confirmation for each test conducted.

.10 Provide any equipment required to conduct tests.

.11 Test water shall be potable water and should be from a municipal system that treats water with chlorination or some other appropriate means to kill bacteria.

1.28 ACCESS DOORS

.1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting and servicing.

.2 Flush mounted 600 mm x 600 mm for body entry and 300 mm x 300 mm for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.

.3 Material:
.1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Departmental Representative.
.2 Remaining areas: use prime coated steel.

.4 Installation:
.1 Locate so that concealed items are accessible.
.2 Locate so that hand or body entry as applicable is achieved.
.3 Installation by General Contractor.

.5 Fire rated access panels: 16 ga. mounting frame, 20 gauge sandwich type insulated self-closing door with concealed hinge, 50 mm thickness of fire rated insulation in door, self-latching ring pull latch, primer coated, 1½ hour rating.

.6 Access doors must maintain fire rating if installed in a fire rated assembly. Refer to Architectural Drawings for location of fire rated walls and ceilings.

.7 Furnish and locate access doors for concealed valves, traps, strainers, cleanouts, balancing and fire dampers, air vents and other parts requiring accessibility for service and maintenance.

1.29 DIELECTRIC COUPLINGS

.1 General:
.1 To be compatible with and to suit pressure rating of piping system.
.2 Where pipes of dissimilar metals are joined.

1.29 DIELECTRIC COUPLINGS (Cont'd)

.1 (Cont'd)
.3 Coupling type shall be as follows unless otherwise noted in specific Sections.

.2 Pipes NPS 2 and under: isolating unions.

.3 Pipes NPS 2-1/2 and over: isolating flanges.

1.30 DRAIN VALVES

.1 Locate at low points and at section isolating valves unless otherwise specified.

.2 Minimum NPS 3/4 unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.

1.31 CUTTING, PATCHING & MAKING GOOD

.1 All cutting and patching shall be by Division 01.

.2 Division 21, 22, 23 and 25 shall advise the trade responsible for cutting, in advance of the time required, of the location and extent of cutting required, and any other pertinent information.

.3 Division 21, 22, 23 and 25 shall advise the trade responsible for patching and finishing of any pertinent information, such as clearance requirements around equipment.

.4 Costs arising to correct work due to failure to provide co-ordination information on time, incorrect sizes or locations or other pertinent information, shall not be extra to the Owner.

1.32 MECHANICAL SYSTEM SHUTDOWN

.1 Comply with Institution's shutdown procedures.

1.33 EXAMINATION OF SITE AND INFORMATION

.1 Material and equipment shall be brought into the building in such assemblies and sizes as to enter into the spaces where they are to be located and to be small enough to be hoisted into the building without difficulty. Any cutting, patching, etc. involved in getting large assemblies into place shall be the responsibility of the Contractor. Coordinate with Division 01.

.2 Immediately inform the Departmental Representative in writing, of all discrepancies, errors, omissions, contradictions and ambiguities. The necessary Addendum or bulletin will be issued to all Bidders. Include a complete cross-checking of Drawing and Specifications for sizes and quantities to correspond correctly. Oral, telephone or E-mail instructions are not valid. Bring obvious discrepancies or omissions to the attention of the Departmental Representative during the Tender Period. Questions may be presented by bidders up to time of tender closing. Questions presented near this time may not be answered.

1.34 CO-ORDINATION

.1 Locate distribution systems, equipment and materials to provide minimum interference and maximum useable space.

.2 Where interference occurs, Departmental Representative shall approve relocation of equipment and materials.

.3 This contractor shall notify other Subcontractors who are concerned, of all openings, foundation work, hangers, inserts, anchors, or other provisions necessary in their work for the installation of this work and he shall furnish all information and necessary materials in ample time so that proper provisions can be made for same, and shall supply and correctly and accurately place all inserts sleeves, anchors, etc.

1.34 CO-ORDINATION (Cont'd)

.4 Where anchors are required to be drilled and placed, this Division shall be responsible for their supply and installation. Pipe hangers and supports listed in Section 23 05 29 - Hangers and Supports for HVAC Piping & Equipment shall be provided by Division 23.

1.35 REQUIREMENTS OF INSPECTION DEPARTMENTS

.1 All work shall be installed in accordance with all laws and regulations of all authorities having jurisdiction in each case, particularly all affected departments of the Municipality and Province. Electrical equipment supplied must conform to the regulations of CSA and the local utility. Anything necessary to make the work comply with these requirements shall be provided by this contractor without additional cost to the Owners if reasonably could have been foreseen when tendering.

.2 The Contractor shall prepare drawings as may be required by Authority Having Jurisdiction Departments having jurisdiction, and obtain their approval before proceeding with the work.

.3 In the event that the Authority Having Jurisdiction's request deviations from the layout, contractor shall consult the Departmental Representative before proceeding with same.

.4 Provide all inspection certificates prior to request for substantial completion. Include copy of inspection certificates in Operation and Maintenance Manuals.

1.36 DRAWINGS

.1 The drawings shall be considered to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.

1.36 DRAWINGS (Cont'd)

.2 The drawings show the approximate location for the special apparatus and the materials throughout the building. The arrangement shown on the drawings is more or less diagrammatic and as such approximated only, and may be altered, as approved by the Departmental Representative, to meet the requirements of the apparatus, etc., and of the building. Each Subcontractor shall be held responsible for all measurements for his work throughout, and he shall arrange his piping, wiring and apparatus to conform to the Architectural and Structural details in a satisfactory manner and shall cooperate with other contractors to ensure that work shall meet all requirements of diverse Contracts.

.3 The contractor is particularly cautioned that small scale Departmental Representative's plans must be supplemented by his own detail drawings where necessary for proper coordination of the work.

.4 Items shown on the drawings but not specified or specified but not shown shall be included.

.5 Items obviously required to provide a complete working system, but not specified nor shown shall be included.

.6 In order to show more clearly the arrangement of the work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standards details and to the specifications to determine the requirements.

.7 Certain details indicated on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.

1.36 DRAWINGS (Cont'd)

.8 All piping and ductwork in finished areas shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or ductwork shall be installed in such areas unless specifically reviewed by the Departmental Representative. No piping shall be concealed in outside walls.

.9 Vent pipes, exhaust hoods or other mechanical equipment mounted on roof, or housing for such equipment, shall not be closer to the edge of roof than 1.8 m (6'-0"), unless specifically reviewed by the Departmental Representative.

.10 Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other trades, shall be made at no extra cost to the Owner.

.11 Leave areas clear of piping and ducts where space is indicated reserved for future equipment, and equipment for other trades.

.12 Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.

.13 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Departmental Representative before proceeding with the work.

.14 Before fabricating ductwork or piping for installation, make certain that such items can be installed as shown on the drawings without interfering with the structure or the work of all other trades. Any problems that cannot be solved in agreement with the other trades affected, shall be submitted for decision. If ductwork or piping is prefabricated prior to the investigation and reaching for a solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Owner.

1.36 DRAWINGS (Cont'd)

.15 Off-sets in piping and ductwork may not be indicated in all cases, but are to be included in the contract as required.

.16 The location and size of existing services shown on the Drawings are based on the best available information. The actual location, and size, of existing services shall be verified in the field before work is commenced.

.17 Refer to 'Co-ordination Drawings' for additional requirements.

1.37 HOISTING AND RIGGING

.1 In accordance with the construction schedule provide and arrange for transportation, of all equipment and materials to site, and for the rigging, hoisting, storing and setting in place of equipment.

1.38 WORKMANSHIP AND QUALIFICATIONS OF WORKERS

.1 Perform the work in a neat and careful manner so that items are installed, and will remain, plumb, square and straight. Items not so installed will be rejected and redone at no extra cost to the Owner.

.2 When required either by the specifications or manufacturers instructions, have manufacturer or his accredited agent or the supplier supervise the work.

1.38 WORKMANSHIP AND QUALIFICATIONS OF WORKERS (Cont'd)

.3 Provide qualified tradespeople to perform all the work. Tradespeople to have a minimum of 3 years of similar experience. Provide an on-site supervisor to supervise the work of Division 21, 22 23 and 25. When requested of the Departmental Representative, provide documentation demonstrating experience of tradespeople and supervisor. If tradesperson or supervisor does not have adequate experience of qualifications remove from site and provide suitable replacement. Site supervisor to have minimum of 10 years of experience with demonstrated supervisory experience on similar sized projects. Provide resume of site supervisor to Departmental Representative prior to start of project. Departmental Representative has the right to reject or remove at any time any worker or site supervisor if in his opinion the individual does not possess the required experience or qualifications. When personnel has been removed or rejected provide suitable replacement.

.4 No horseplay will be tolerated on site at any time. The contractor shall be responsible for putting an immediate end to all horseplay.

1.39 GUARANTEE

.1 This contractor shall guarantee all material and workmanship used in the work to be in strict accordance with the specifications, of best quality and type obtainable to give first-class construction and proper and efficient operation, and free from any defects. Any such defects which may appear in any of the work within one year after written acceptance of this work shall be repaired and replaced by this contractor without additional expense to the Departmental Representative. Where such defects occur, this contractor shall be held responsible for all costs incurred in making the defective work good.

.2 This shall not overturn any longer warranties on specific items of equipment.

1.39 GUARANTEE (Cont'd)

.3 All injuries to adjacent work particularly plaster, wood finishes or other materials, or damage to other equipment, caused by such defects of this contractor's work or by subsequent replacement and repairs, shall be made good at the expense of this contractor. All repair work shall be done by trades responsible for the original work.

1.40 EQUIPMENT INFORMATION FORM

.1 Contractor to ensure that for each piece of equipment to be decommissioned, SNC Lavalin "Equipment Information Form CMMS" is completed. Refer to template form in specification.

1.41 REVIEW/ TAKEOVER PROCEDURES

.1 Conform to Division 01 - Section 01 77 00.

.2 Substantial performance will not be considered until the following items have been completed to the Departmental Representative's satisfaction.

.1 All systems are complete and operational.

.2 All systems have been commissioned and successfully passed testing over the entire range of their operating capacities under automatic control. (Note: seasonal or environmental conditions resulting in the delay of some testing will be accommodated by issuance of conditional certificate).

.3 Commissioning and testing reports.

.4 Air balancing reports.

.5 "As-built" and/or record drawings.

.6 Operations and Maintenance Manuals.

.7 The Owner, operating and maintenance personnel have received training on all systems and equipment.

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 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Procedures.

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

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 CONNECTIONS TO EQUIPMENT

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.2 CLEARANCES

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

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

3.3 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 AIR VENTS

.1 Install manual air vents at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

3.5 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.

3.6 PIPEWORK INSTALLATION

.1 Screwed fittings jointed with Teflon tape.

.2 Protect openings against entry of foreign material.

.3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.4 Assemble piping using fittings manufactured to ANSI standards.

.5 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.6 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.7 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.8 Install, except where indicated, to permit separate thermal insulation of each pipe.

.9 Group piping wherever possible and as indicated.

.10 Ream pipes, remove scale and other foreign material before assembly.

.11 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.12 Provide for thermal expansion as indicated.

.13 Valves:
.1 Install in accessible locations.
.2 Remove interior parts before soldering.
.3 Install with stems above horizontal position unless otherwise indicated.
.4 Valves accessible for maintenance without removing adjacent piping.
.5 Install globe valves in bypass around control valves.
.6 Use gate or ball valves at branch take-offs for isolating purposes except where otherwise specified.

3.6 PIPEWORK INSTALLATION (Cont'd)

.13 (Cont'd)
.7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
.8 Install ball valves for glycol service.
.9 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

.14 Check Valves:
.1 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

3.7 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.2 Material: schedule 40 black steel pipe.

.3 Construction: foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

.4 Sizes: 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: Provide space for firestopping. Maintain fire rating integrity.
.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

3.7 SLEEVES (Cont'd)

.6 (Cont'd)
.4 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

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

.2 Construction: one piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.9 PREPARATION FOR FIRE STOPPING

.1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Fire Stopping.

.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.

3.10 FLUSHING OUT OF PIPING SYSTEMS

.1 Flush system in accordance with Section 23 08 02.

.2 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.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Departmental Representative.

.6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.12 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by Departmental Representative.

.2 Request written approval 10 days minimum, prior to commencement of work.

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

.4 Ensure daily clean-up of existing areas.

3.13 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 REFERENCES

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
.1 ANSI/ASME B31.1-2010, Power Piping.
.2 ANSI/ASME B31.3-2010, Process Piping.
.3 ANSI/ASME Boiler and Pressure Vessel Code-2010:
.1 BPVC 2010 Section I: Power Boilers.
.2 BPVC 2010 Section V: Nondestructive Examination.
.3 BPVC 2010 Section IX: Welding and Brazing Qualifications.

.2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
.1 ANSI/AWWA C206-11, Field Welding of Steel Water Pipe.

.3 American Welding Society (AWS)
.1 ANSI/AWS C1.1M/C1.1:2000(R2006), Recommended Practices for Resistance Welding.
.2 ANSI/AWS Z49.1:2005, Safety in Welding, Cutting and Allied Process.
.3 AWS WI:2000, Welding Inspection Handbook.
.4 AWS B3.0-1941, Welding Procedure and Performance Qualification.

.4 Canadian Standards Association (CSA International)
.1 CSA W47.2-11, Certification of Companies for Fusion Welding of Aluminum.
.2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
.3 CSA B51-09, Boiler, Pressure Vessel and Pressure Piping Code. Includes Update No. 1 (2009).
.4 CSA W117.2-06, Safety in Welding, Cutting and Allied Processes.
.5 CSA W178.1-08, Certification of Welding Inspection Organizations.
.6 CSA W178.2-08, 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 and T.S.S.A.
    .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
    .3 Submit welder's qualifications to Departmental Representative.
    .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 and T.S.S.A.
    .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, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

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

PART 2 - PRODUCTS

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

PART 3 - EXECUTION

3.1 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, ANSI/AWS C1.1M/C1.1, special procedures specified elsewhere in Mechanical Divisions, and applicable requirements of provincial authority having jurisdiction.

3.2 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:
.1 Where used, fit to minimize gaps between ring and pipe bore.
.2 Do not install at orifice flanges.

.3 Fittings:
.1 NPS 2 and smaller: install welding type sockets.
.2 Branch connections: install welding tees or forged branch outlet fittings.

3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS

.1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.

.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS (Cont'd)

.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.

3.4 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 Departmental Representative.
.2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
.3 As required by T.S.S.A.
.4 Inspect and test 10% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and full gamma ray radiographic (hereinafter referred to as "radiography") tests.

.2 Hydrostatically test welds to ANSI/ASME B31.3 and T.S.S.A.

.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 Departmental Representative of total of up to 10% of welds, selected at random by Departmental Representative by radiographic tests.

.5 Full radiographic tests for piping systems.
.1 Spot radiography:
.1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Departmental Representative from welds which would be most difficult to repair in event of failure after system is operational.
.2 Radiographic film:

3.4 SPECIALIST EXAMINATIONS AND TESTS (Cont'd)

.5 (Cont'd)

.2 (Cont'd)

.1 Identify each radiographic film with date, location, name of welder, and submit to Departmental Representative. Replace film if rejected because of poor quality.

.3 Interpretation of radiographic films:

.1 By qualified radiographer.

.4 Failure of radiographic tests:

.1 Extend tests to welds by welder responsible for failed tests.

3.5 DEFECTS CAUSING REJECTION

.1 As described in ANSI/ASME B31.3 and ANSI/ASME Boiler and Pressure Vessels Code.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

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

3.7 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

.1 Section 23 05 53.01 - Mechanical Identification.

1.3 REFERENCES

.1 American Society of Mechanical Engineers (ASME).
.1 ANSI/ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
.2 ANSI/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.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00.

.2 Submit shop drawings and product data.

.3 Submit manufacturer's product data for following items:
.1 Thermometers.
.2 Pressure gauges.
.3 Stop cocks.
.4 Syphons.
.5 Wells.
.6 Pressure snubbers.

1.5 HEALTH AND SAFETY

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Design point to be at mid point of scale or range.

.2 Ranges: suitable for operating range of system.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, liquid filled, 225 mm scale length: to CAN/CGSB-14.4.

2.3 REMOTE READING THERMOMETERS

.1 100 mm diameter inert gas filled activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting.

2.4 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass or stainless steel.

2.5 PRESSURE GAUGES

.1 112 mm, dial type: to ANSI/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 Gasketted pressure relief back with solid front.

.4 Bronze stop cock.

.5 Oil filled for high vibration applications.

PART 3 - EXECUTION

3.1 GENERAL

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

.2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

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

.2 Install in locations as indicated and on inlet and outlet of:
- .1 Water heating and cooling coils.
- .2 Water boilers.
- .3 DHW tanks.
- .4 Heat exchangers.

.3 Install wells for balancing purposes, elsewhere as required to achieve proper readings.

.4 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

.1 Install in following locations:
- .1 Suction and discharge of pumps.
- .2 Upstream and downstream of PRV's.
- .3 Upstream and downstream of control valves.
- .4 Inlet and outlet of coils.
- .5 Outlet of boilers.
- .6 In other locations as indicated.

.2 Install gauge cocks for balancing purposes, elsewhere as required to achieve proper readings.

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

3.4 NAMEPLATES

.1 Install engraved lamicoid nameplates as specified in Section 23 05 53.01, identifying medium.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:
.1 Valves, gate and check.

.2 Related Sections:
.1 Section 01 35 29 - Health and Safety Requirements.
.2 Section 23 05 05 - Installation of Pipework.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
.1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
.2 ANSI/ASME B16.18-2001(R2005), Cast Copper Alloy Solder Joint Pressure Fittings.
.3 ANSI/ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.

.2 American Society for Testing and Materials International (ASTM).
.1 ASTM A49-01(2006), Specification for Heat-Treated Carbon Steel Joint Bars, Microalloyed Joint Bars, and Forged Carbon Steel Compromise Joint Bars.
.2 ASTM A126-04(2009), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
.3 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
.4 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
.5 ASTM B85/B85M-10, Standard Specification for Aluminum-Alloy Die Castings.
.6 ASTM B209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
.7 ASTM A276-10, Standard Specification for Stainless Steel Bars and Shapes.
.8 ASTM B283/B283M-11a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).

1.2 REFERENCES (Cont'd)

.2 (Cont'd)

.9 ASTM B505/B505M-10, Standard Specification for Copper Alloy Continuous Castings.

.10 ASTM B16/B16M-10, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.

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

.1 MSS SP-70-2006, Gray Iron Gate Valves, Flanged and Threaded Ends.

.2 MSS SP-71-2005, Gray Iron Swing Check Valves, Flanged and Threaded Ends.

.3 MSS SP-82-1002, Valve Pressure Testing Methods.

.4 MSS SP-25-2008, Standard Marking System for Valves, Fittings, Flanges and Unions.

.5 MSS SP-80-2008, Bronze Gate Globe, Angle and Check Valves.

.6 MSS SP-110-2010, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

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

.2 Submit WHMIS MSDS - Material Safety Data Sheets.

.3 Shop Drawings:

.1 Submit data for valves specified in this Section.

1.4 CLOSEOUT SUBMITTALS

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

.2 Product Data:

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

1.4 CLOSEOUT SUBMITTALS (Cont'd)

.2 (Cont'd)
.2 Submit data for valves specified in this section.

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

1.5 QUALITY ASSURANCE

.1 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:
.1 Furnish following spare parts:
.1 Valve seats: one for every 10 valves each size, minimum 1.
.2 Discs: one for every 10 valves, each size. Minimum 1.
.3 Stem packing: one for every 10 valves, each size. Minimum 1.
.4 Valve handles: 2 of each size.
.5 Gaskets for flanges: one for every 10 flanged joints.
.2 Tools:
.1 Furnish special tools for maintenance of systems and equipment.

1.7 DELIVERY, STORAGE AND HANDLING

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

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

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Valves:
.1 Except for specialty valves, to be single manufacturer.
.2 Products to have CRN registration numbers.

.2 Standard specifications:
.1 Gate valves: MSS SP-70.
.2 Globe valves: MSS SP-85.
.3 Check valves: MSS SP-71.

.3 Requirements common to valves, unless specified otherwise:
.1 Body, bonnet: cast iron to ASTM B209 Class B.
.2 Connections: flanged ends plain face to ANSI/ASME B16.1.
.3 Inspection and pressure testing: to MSS SP-82.
.4 Bonnet gasket: non-asbestos.
.5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
.6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
.7 Gland packing: non-asbestos.
.8 Handwheel: Die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
.9 Identification tag: with catalogue number, size, other pertinent data.

.4 All products to have CRN registration numbers.

.5 End Connections:
.1 Connection into adjacent piping/tubing:
.1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
.2 Copper tube systems: solder ends or threaded ends to ANSI/ASME B16.18.

.6 Lockshield Keys:
.1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

2.1 MATERIALS
(Cont'd)

.7 Gate Valves:
.1 NPS 2 and under, bronze, solid wedge disc:
.1 Standard specification: MSS SP-80.
.2 Bonnet: with hex. shoulders.
.3 Connections: with hex. shoulders.
.4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
.5 Packing: high grade non-asbestos packing.
.6 Handwheel: non-ferrous. Nut: bronze to ASTM B62.
.7 Body: with long disc guides, screwed bonnet with stem retaining nut.

.8 Globe Valves:
.1 Requirements common to globe valves, unless specified otherwise:
.1 Standard specification: MSS SP-80.
.2 Bonnet: union with hexagonal shoulders.
.3 Connections: screwed with hexagonal shoulders.
.4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
.5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
.6 Handwheel: non-ferrous.
.7 Handwheel Nut: bronze to ASTM B62.
.2 NPS 2 and under, plug disc, Class 150, screwed ends:
.1 Body and bonnet: union bonnet.
.2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
.3 Operator: handwheel.
.3 Angle valve, NPS 2 and under, composition disc, Class 150:
.1 Body and bonnet: union bonnet.
.2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
.3 Operator: lockshield.

.9 Check Valves:

2.1 MATERIALS (Cont'd)

.9 (Cont'd)
.1 NPS 2 and under, bronze swing type, bronze disc:
.2 Standard specification: MSS SP-80.
.3 Connections: with hex. shoulders.
.4 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
.5 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.10 Ball Valves:
.1 NPS 2 and under:
.1 Body and cap: cast high tensile bronze to ASTM B62 or brass to ASTM B16/B16M.
.2 Stem: tamperproof ball drive.
.3 Stem packing nut: external to body.
.4 Ball and seat: stainless steel solid full port ball and teflon seats.
.5 Stem seal: PTFE with external packing nut.
.6 Operator: removable lever handle.

.11 Circuit Balancing Valves:
.1 Sizes: calibrated balancing valves, as specified.
.2 NPS-2 and under:
.1 General:
.1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter.
.2 Accuracy:
.1 Readout to be within plus or minus 2% of actual flow at design flow rate.
.3 Pressure die-cast dezincification resistant copper alloy construction, Teflon disc, screw-in bonnet.
.1 Flow control: At least four (4) full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
.4 Insulation:
.1 Use prefabricated shipping packaging of 5.4 R polyurethane as insulation.
.5 Drain connection:

2.1 MATERIALS (Cont'd)

.11 (Cont'd)
.2 (Cont'd)
.1 NPS 3/4 valved and capped, suitable for hose socket.
.2 Incorporated into valve body or provided as separate item.

2.2 GATE VALVES

.1 NPS 2½ - 8, cast iron, bronze iron trim, solid wedge disc:
.1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly.
.2 Disc: solid offset taper wedge, bronze to ASTM B62 up to and including NPS 3, bronze rings rolled into cast iron disc on other sizes, secured to bronze stem to ASTM B62.
.3 Seat rings: renewable bronze to ASTM B62, screwed into body.
.4 Stem: bronze to ASTM B623

2.3 UNDERWRITERS APPROVED GATE VALVE

.1 NPS 2 1/2 - 14, OS&Y:
.1 Approvals: UL and FM approved for fire service.
.2 UL and FM Label: on valve yoke.
.3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI/ASME B16.1 and ULC ORD-C262.
.4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
.5 Packing gland: bronze.
.6 Stem: manganese bronze. Diameter to ULC ORD-C262.
.7 Stuffing box dimensions, glad bolt diameter: to ULC ORD-C262.
.8 Bosses for bypass valve, drain: on NPS 4 and over.
.9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.
.10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
.11 Pressure rating:
.1 NPS 2-1/2 - 12: 1.7 MPa CWP.
.2 NPS 14: 1.2 MPa CWP.
.12 Operator: handwheel.

2.4 VALVE OPERATORS

.1 Install valve operators as follows:
.1 Handwheel: on valves except as specified.
.2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

2.5 CHECK VALVES

.1 NPS 2½ and over:
.1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin.
.1 Up to NPS 16: cast iron to ASTM A126 Class B.
.2 Disc: Rotating for extended life.
.1 Up to NPS 6: bronze to ASTM B62.
.2 NPS 8 and over: bronze-faced cast iron.
.3 Seat rings: renewable bronze to ASTM B62 screwed into body.
.4 Hinge pin, bushings: renewable bronze to ASTM B62.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Handwheel with chain operators are to be installed on all valves more than 2400mm above floor in mechanical rooms.

.3 Remove internal parts before soldering or brazing.

.4 Install all valves such that adequate clearance is provided to allow for obstruction free operation.

.5 Install valves at all branch take-offs and to isolate each piece of equipment, and as indicated.

.6 For all threaded valves provide one screwed union beside each valve to allow easy replacement of valve.

3.1 INSTALLATION (Cont'd)

.7 Install all valves as per manufacturers' instructions.

3.2 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 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ANSI/ASME B31.1-10, Power Piping.

.2 ASTM International
- .1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
- .2 ASTM A307-10, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
- .3 ASTM A563-07a, Standard Specification for Carbons and Alloy Steel Nuts.

.3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
- .1 MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation.

.4 Underwriter's Laboratories of Canada (ULC)

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 data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada for fabricated custom structural assemblies.
- .2 Submit shop drawings for:
  - .1 Bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

.4 Manufacturers' Instructions:

1.2 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.4 (Cont'd)
.1 Provide manufacturer's installation instructions.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements:
.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 ANSI/ASME B31.1 or MSS SP-58.
.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 SP-58.

2.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP-58 and ANSI/ASME B31.1.

.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 electro-plating galvanizing process.
.3 Ensure steel hangers in contact with copper piping are epoxy coated.

.2 Upper attachment structural: suspension from lower flange of I-Beam:
.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
.1 Rod: 9 mm UL listed.
.2 Cold piping NPS 2-1/2 or greater, all 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 SP-58.

.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 SP-58.
.2 Cold piping NPS 2-1/2 or greater, all 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 SP-58.

2.3 PIPE HANGERS (Cont'd)

.5 Hanger rods: threaded rod material to MSS SP-58:
.1 Ensure that hanger rods are subject to tensile loading only.
.2 Provide linkages where lateral or axial movement of pipework is anticipated.
.3 Do not use 22 mm or 28 mm rod.

.6 Pipe attachments: material to MSS SP-58:
.1 Attachments for steel piping: carbon steel black.
.2 Attachments for copper piping: copper plated black steel.
.3 Use insulation shields for hot pipework
.4 Oversize pipe hangers and supports for hot pipework.

.7 Adjustable clevis: material to MSS SP-58, UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-58.

.9 U-bolts: carbon steel to MSS SP-58 with 2 nuts at each end to ASTM A563.
.1 Finishes for steel pipework: black.
.2 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion plastic coated.

.10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-58.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP-58, type 42, UL listed.

.2 Copper pipe: carbon steel copper plated to MSS SP-58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:
.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP-58, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:
.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP-58.

2.6 CONSTANT SUPPORT SPRING HANGERS

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

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

2.7 VARIABLE SUPPORT SPRING HANGERS (Cont'd)

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

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

2.8 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 OTHER EQUIPMENT SUPPORTS

.1 Submit structural calculations with shop drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with:
.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:
.1 Install on piping systems at pumps, boilers and as indicated elsewhere.

.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.

3.1 INSTALLATION (Cont'd)

.3 (Cont'd)
.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.

3.2 HANGER SPACING

.1 Plumbing piping: to Ontario Plumbing Code and authority having jurisdiction.

.2 Fire protection: to applicable fire code.

.3 Gas piping: up to NPS 1/2: every 1.8 m.

.4 Copper piping: up to NPS 1/2: every 1.5 m.

.5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

.7 Pipework greater than NPS 12: to MSS SP-58.

3.3 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.

3.4 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.

3.5 FINAL ADJUSTMENT

.1 Adjust hangers and supports:
.1 Ensure that rod is vertical under operating conditions.
.2 Equalize loads.

.2 Adjustable clevis:

3.5 FINAL ADJUSTMENT (Cont'd)

.2 (Cont'd)
.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.

3.6 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 RELATED SECTIONS

.1 Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.

1.2 SHOP DRAWINGS

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

.2 Provide separate shop drawings for each isolated system complete with performance and product data.

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 ELASTOMERIC PADS

.1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

.2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.

.3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.

.4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded, to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

.1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring to be between 0.8 to 1.0.

.3 Cadmium plate for all installations.

.4 Colour code springs.

2.5 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

.6 Performance: to suit application.

2.6 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

.6 Performance: to suit application.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

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

2.8 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

3.1 INSTALLATION (Cont'd)

.2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
.1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
.2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.2 SITE VISIT

.1 Manufacturer to visit site and provide written certification that installation is in accordance with manufacturer's instructions and submit report to Departmental Representative.

.2 Provide Departmental Representative with notice 24 hours in advance of visit.

.3 Make adjustments and corrections in accordance with written report.

3.3 TESTING

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93.

.2 Vibration measurements shall be taken for equipment. listed below:.

3.3 TESTING (Cont'd)

.2 (Cont'd)
- .1 Air handling units.
- .2 Heat recovery units.
- .3 Pumps.
- .4 Unit heaters.
- .5 Exhaust fans.

.3 Provide Departmental Representative with notice 24 hours in advance of commencement of tests.

.4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.5 Submit complete report of test results including sound curves.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA)
.1 CSA B149.1-10, Natural Gas and Propane Installation Code, Includes Update No. 1 (2010).

.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 10-2010, Standard for Portable Fire Extinguishers.
.2 NFPA 13-2010, Standard for the Installation of Sprinkler Systems.
.3 NFPA 14-2010, Standard for the Installation of Standpipes and Hose Systems.

1.2 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.

1.3 QUALITY ASSURANCE

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

.2 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety.

1.4 DELIVERY, STORAGE, AND HANDLING

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

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 or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:
.1 Conform to following table:

2.2 SYSTEM

.3 (Cont'd)

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 and Service Corridors: use size #9.

.5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
.1 Use arrangement of Main identifier, Source identifier, Destination identifier.
.2 Equipment in Mechanical Room:
.1 Main identifier: size #9.
.2 Source and Destination identifiers: size #6.
.3 Terminal cabinets, control panels: size #5.
.3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Where existing identification system does not cover for new work, use identification system specified this section.

.2 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 PIPING SYSTEMS

.1 Identification:

2.4 PIPING SYSTEMS GOVERNED BY CODES (Cont'd)

.1 (Cont'd)
.1 Natural gas: to CSA B149.1 and authority having jurisdiction.
.2 Sprinklers: to NFPA 13.
.3 Standpipe and hose systems: to NFPA 14.
.4 Fire hose cabinets: to NFPA 14.
.5 Fire extinguishers: to NFPA 10.

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 plastic-coated cloth 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.

2.5 IDENTIFICATION OF PIPING SYSTEMS (Cont'd)

.7 Colours and Legends:

.1 Where not listed, obtain direction from Departmental Representative.

.2 Colours for legends, arrows: to following table:

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

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Sprinklers	Red	SPRINKLERS
Vacuum	Yellow	LAB. VAC.
Compressed Air	Green	COMP. AIR
RO Water Supply	Green	RO SUPPLY
RO Water Return	Green	RO RETURN

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 LANGUAGE

.1 Identification in English.

PART 3 - EXECUTION

3.1 TIMING

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

3.2 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

.3 Identify systems, equipment to conform to PWGSC PMSS.

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 Departmental Representative. 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 GENERAL

.1 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.

.2 Standard: TAB to be most stringent of TAB standards of AABC, NEBB, SMACNA and ASHRAE.

.3 Do TAB of all systems, equipment, components, controls specified in Division 23.

.4 TAB shall be performed by an independent TAB agency engaged by the contractor.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Names of personnel it is proposed to perform TAB to be submitted to and approved by Departmental Representative within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.

.2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

.3 Co-ordinate TAB with controls, mechanical and electrical contractors.

1.6 PRE-TAB REVIEW

.1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Divisions 22 and 23.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

.1 Notify Departmental Representative 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, caulking complete.

.5 All pressure, leakage, other tests specified elsewhere in Divisions 22 and 23.

.6 All 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.

.9 All fume hood exhaust dampers are operational.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

1.9 START OF TAB (Cont'd)

.7 (Cont'd)
.3 (Cont'd)
.4 Isolating and balancing valves installed, open.
.5 Calibrated balancing valves installed, at factory settings.
.6 Chemical treatment systems complete, operational.

.8 Balancing contractor to test full range of fume hood flow modulation. Flow to be adjusted with all fume hoods open as well as all hoods closed.

1.10 APPLICATION TOLERANCES

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

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments to be 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 Departmental Representative.

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

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

1.15 TAB REPORT

.1 Format to be 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 1 copy of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide manpower and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results to be at discretion of Departmental Representative.

.4 Bear costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, 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. Markings not to be eradicated or covered in any way.

1.18 COMPLETION OF TAB

.1 TAB to be considered complete when final TAB Report received and approved by Departmental Representative.

1.19 SYSTEMS

.1 Quality assurance: Perform TAB under direction of supervisor qualified by AABC.

.2 Air Systems: Include both specified and measured data.

.1 Air Handling Equipment:

.1 Maximum air flow volume.
.2 Fan total pressure.
.3 Motor volts, amps and power.
.4 Minimum outside air volume.
.5 Fan rotational speed.
.6 Fan Power, calculate fan efficiency.
.7 Inlet and outlet dry bulb, wet bulb and dewpoint temperatures.
.8 Equipment static pressure profile.
.9 Noise.
.10 Vibration.

.2 Duct Air Quantities - Mains and Branches:

.1 Duct size.
.2 Number of pressure/velocity readings per traverse.
.3 Sum of velocity measurements.
.4 Average velocity.
.5 Duct air flow volume.
.6 Barometric pressure and duct air temperature.

.3 Air Outlets:

.1 Outlet location and designation.
.2 Manufacturers catalogue identification and type.
.3 Air outlet flow factors. Use 1.0 when flow hood is used.
.4 Air flow volumes.
.5 Exhaust air flow at each fume hood.
.6 Flow at each volume control damper.
.7 Deflector vane or diffuser cone settings.

.3 Hydronic Systems: Include both specified and measured data.

.1 Pumps:

1.19 SYSTEMS (Cont'd)

.3 (Cont'd)

.1 (Cont'd)

.1 Discharge and suction pressures, at design flow and no flow.

.2 Fluid flow rate. Calculate from pump curves if metering not provided.

.3 Motor volts, amps, power.

.4 RPM.

.5 Noise.

.6 Vibration.

.2 Piping Systems:

.1 Supply and return of each primary loop.

.2 Supply and return of each secondary loop.

.3 Domestic hot water recirculation.

.3 Heating Equipment:

.1 Equipment type, location and designation.

.2 Fluid used. Identify fluid used (ie. water, % water/ethylene glycol mixes, etc.).

.3 Fluid flow rate.

.4 Fluid Specific Heat, at mean temperature.

.5 Fluid Specific Gravity, at mean temperature.

.6 Fluid entering and leaving temperatures and pressures.

.7 Heat transfer rate.

.4 Air Heating and Cooling Coils:

.1 Coil type and identification, location and designation.

.2 Entering and leaving air dry and wet bulb temperatures.

.3 Air static pressure drop.

.4 Air flow volume.

.5 Barometric pressure.

.6 Air side heat transfer rate.

.7 Fluid used. Identify fluid used (ie. refrigerant, etc.)

.8 Fluid flow rate.

.9 Fluid Specific Heat, at mean temperature.

.10 Fluid Specific Gravity, at mean temperature.

.11 Fluid entering and leaving temperatures and pressures.

.12 Fluid side heat transfer rate.

.5 Unit and Cabinet Heater:

1.19 SYSTEMS (Cont'd)

.3 (Cont'd)
.5 (Cont'd)
.1 Start unit and check for noise or vibration.
.2 Check unit performance for each fan speed:
.1 Air flow and temperature rise.
.2 Water temperature drop.

1.20 DOMESTIC HWC SYSTEMS

.1 Meet requirements as specified for hydronic systems.

.2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of heaters, tank, pump, circulator, at controllers, controlled device.

.3 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

1.21 OTHER SYSTEMS

.1 Plumbing systems:
.1 TAB procedures:
.1 Flush valves: adjust to suit project pressure conditions.

1.22 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 Building pressure conditions:
.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

.3 Smoke management systems:
.1 Test for proper operation of all fire dampers, installed as component parts of air systems specified Division 23.

1.22 OTHER TAB REQUIREMENTS (Cont'd)

.3 (Cont'd)

.2 At each fire damper location, remove fusible link, allow shutter to close without intervention. Record results on TAB report. At completion of test, restore each shutter to open position and reinstall link. Report non-closing dampers to Mechanical Contractor and Departmental Representative.

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 GENERAL

.1 Ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment to be pressure tested for leaks.

1.2 TIMING

.1 Ducts to be tested before installation of insulation or any other form of concealments.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, gaskets, etc.

1.3 EXCLUSIONS

.1 Flexible connections to air terminal control boxes.

1.4 REFERENCES

.1 SMACNA HVAC Air Duct Leakage Test Manual.

1.5 TEST PROCEDURES

.1 Maximum lengths of ducts to be tested to be consistent with capacity of test equipment.

.2 Section of duct to be tested to include:
.1 Fittings, branch ducts, tap-ins.

.3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.4 Base partial system leakage calculations on Reference Standard.

.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

1.6 TESTING AGENCY

.1 Installing Contractor.

1.7 VERIFICATION

.1 Departmental Representative to witness tests and to verify reported results.

.2 To be certified by the same TAB agency performing TAB on this project.

.3 Provide testing schedule to Departmental Representative 3 days in advance of test. Departmental Representative may authorize un-witnessed testing.

1.8 TEST INSTRUMENTS

.1 Testing agency to provide instruments for tests.

.2 Test apparatus to include:
.1 Fan capable of producing required static pressure.
.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
.3 Flow measuring instrument compatible with the orifice plate.
.4 Calibration curves for orifice plates used.
.5 Flexible duct for connecting to ductwork under test.

.3 Test apparatus to be accurate to within +/-3% of flow rate and pressure.

.4 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.

.5 Test instruments to be calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.

.6 Instruments to be re-calibrated every six months thereafter.

1.9 SYSTEM LEAKAGE TOLERANCES

.1 System leakage tolerances specified herein are stated as a percentage of total flow rate handled by the system. Therefore, when testing sections of ductwork this acceptable leakage shall be pro-rated to entire system. Leakage for sections of duct systems shall not exceed the total allowable leakage.

.2 Leakage tests on following systems not to exceed specified leakage rates.
.1 Small duct systems up to 250 Pa: Leakage 2%.
.2 Large low pressure duct systems up to 500 Pa: Leakage 2%.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

1.10 REPORT FORMS

.1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.

1.11 PRESSURE TEST REPORTS

.1 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
.1 Schematic of entire system.
.2 Schematic of section under test showing test site.
.3 Required and achieved static pressures.
.4 Orifice differential pressure at test sites.
.5 Permissible and actual leakage flow rate (L/s) for test sites.
.6 Witnessed certification of results.

.2 Include test reports in final TAB report.

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 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 90.1-2010 (I-P), Energy Standard for Buildings Except Low-Rise Residential Buildings, (ANSI Approved; IESNA Co-Sponsored).

.2 ASTM International Inc.

.1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335/C335M-10e1, 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 C449-07, 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 C553-08, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

1.1 REFERENCES (Cont'd)

.2 (Cont'd)

.2 (Cont'd)

.7 ASTM C612-10, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795-08, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921-10, 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, Adhesives for Commercial Use.

.5 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.6 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

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 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.

1.2 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.2 (Cont'd)
.1 (Cont'd)
.3 Recommended spare parts list.

.3 Manufacturers' Instructions:
.1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

1.3 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, qualified to standards of TIAC.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address 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°C mean temperature when tested in accordance with ASTM C335/C335M.

2.2 INSULATION (Cont'd)

.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/m^2 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/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921 untreated.

.5 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.

.6 Contact adhesive: quick-setting.

.7 Canvas adhesive: washable.

.8 Banding: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES (Cont'd)

.9 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.

.10 Fasteners: 4 mm diameter pins with 35 mm square clips, length to suit thickness of insulation.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, free from foreign material.

3.2 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 Mechanical fastenings:
.1 On rectangular ducts, use 100% coverage of insulating cement and weld pins at not more than 200 mm centres, but not less than 2 rows per side and bottom.

3.2 INSTALLATION (Cont'd)

.6 (Cont'd)

.2 For round ducts provide row of pins and mechanical fasteners on top of duct. Pins to be spaced at maximum 200 mm centres. Apply vapour barrier tape on vapour barrier seam and over top of mechanical fasteners.

.7 Use stand-offs for duct mounted control accessories, including balancing and control dampers.

.8 Apply 1 mm thick galvanized sheet metal corners (nosings) to ductwork in mechanical rooms and exterior ducting.

3.3 DUCTWORK INSULATION

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

TIAC Code	Vapour Retarder	Thickness (mm)	
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served			none
Acoustically lined ducts	none		

.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.

3.3 DUCTWORK INSULATION SCHEDULE (Cont'd)

.2 (Cont'd)

.1 (Cont'd)

.1 Finishes: conform to following table:

	TIAC Code Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3

3.4 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 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
.1 ANSI/ASHRAE 90.1-2010 (I-P), Energy Standard for Buildings Except Low-Rise Residential Buildings (ANSI Approved; IESNA Co-Sponsored).

.2 American Society for Testing and Materials International (ASTM)
.1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
.2 ASTM C335/C335M-10e1, 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 C449-07, Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
.5 ASTM C533-09, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
.6 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
.7 ASTM C795-08, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
.8 ASTM C921-10, 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.

1.2 REFERENCES (Cont'd)

.4 Department of Justice Canada (Jus)
.1 Canadian Environmental Assessment Act (CEAA), 1992, 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): Mechanical Insulation Best Practice Guide(Revised 2005).

.7 Underwriters' Laboratories of Canada (ULC)
.1 CAN/ULC S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
.2 CAN/ULC S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
.3 CAN/ULC S702-09, Thermal Insulation, Mineral Fibre, for Buildings.
.4 ULC S702.2-10, Mineral Fibre Thermal Insulation 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:

1.4 SUBMITTALS (Cont'd)

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

.3 Shop Drawings:
.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.4 Samples:
.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
.2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
.1 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

.1 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

.2 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.6 DELIVERY, STORAGE AND HANDLING (Cont'd)

.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/C335M.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
.1 Mineral fibre: to CAN/ULC S702, ASTM C547.
.2 Maximum "k" factor: to CAN/ULC S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
.1 Mineral fibre: to CAN/ULC S702, ASTM C547.
.2 Jacket: to CGSB 51-GP-52Ma.
.3 Maximum "k" factor: to CAN/ULC S702, ASTM C547.

.5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
.1 Mineral fibre: to CAN/ULC S702, ASTM C547.
.2 Jacket: to CGSB 51-GP-52Ma.
.3 Maximum "k" factor: to CAN/ULC S702, ASTM C547.

2.2 INSULATION (Cont'd)

.6 TIAC Code A-6: flexible unicellular tubular elastomer.,
.1 Insulation: with vapour retarder jacket.
.2 Jacket: to CGSB 51-GP-52Ma.
.3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.
.4 Maximum "k" factor: 0.27.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

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

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/m^2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

2.8 JACKETS (Cont'd)

.1 (Cont'd)

.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
.2 Colours: white.
.3 Minimum service temperatures: -20 degrees C.
.4 Maximum service temperature: 65 degrees C.
.5 Moisture vapour transmission: 0.02 perm.
.6 Thickness: 0.75 mm.
.7 Fastenings:
.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
.2 Tacks.
.8 Special requirements:
.1 Outdoor: UV rated material at least 0.75 mm thick.

.2 Canvas:

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

.3 Aluminum:

.1 To ASTM B209M.
.2 Thickness: 0.50 mm sheet.
.3 Finish: stucco embossed.
.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

.4 Stainless steel:

.1 Type: 304, 316.
.2 Thickness: 0.25 mm.
.3 Finish: stucco embossed.
.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

2.8 JACKETS (Cont'd)

.4 (Cont'd)
.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 92 00.

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.

.2 Design: to permit movement of expansion joint and to permit periodic removal and replacement damage to adjacent insulation.

.3 Insulation:
.1 Insulation, fastenings and finishes: same as system.

3.4 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.5 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.
.1 Securements: SS bands at 300 mm on centre.
.2 Seals: lap seal adhesive, lagging adhesive.
.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.
.1 Securements: SS bands at 300 mm on centre.
.2 Seals: VR lap seal adhesive, VR lagging adhesive.
.3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.
.1 Seals: lap seal adhesive, lagging adhesive.

.5 TIAC Code: C-2 with vapour retarder jacket.
.1 Seals: lap seal adhesive, lagging adhesive.
.2 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

3.5 PIPING INSULATION SCHEDULES (Cont'd)

.6 (Cont'd)
.1 Seals: lap seal adhesive, lagging adhesive.
.2 Installation: TIAC Code: 1501-H.

.7 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.

Applications	Temp degree 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
Glycol 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
Domestic CWS with vapour retarder		C- 2	25	25	25	25	25	25
Domestic TW and TWR(4)		A-1	25	25	25	25	25	25
Sanitary Vent(2)		A-3				25	25	

.8 Finishes:
.1 Exposed indoors: PVC jacket.
.2 Exposed in mechanical rooms: aluminum or PVC jacket.
.3 Exposed in cell area Y-chases: aluminum.

3.5 PIPING INSULATION SCHEDULES (Cont'd)

.8 (Cont'd)

.4 Concealed, indoors: canvas on valves, fittings. No further finish.

.5 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.6 Outdoors: water-proof SS jacket.

.7 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.

.8 Installation: to appropriate TIAC code CRF/1 through CPF/5.

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 General

.1 The purpose of this section is to specify Division 23 responsibilities in the commissioning process.

.2 The systems to be commissioned are listed in Section 01 91 00.1.9.

.3 Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 23 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 Responsibilities

.1 Mechanical Contractor. The responsibilities of the HVAC contractor, during construction and acceptance phases in addition to those listed above are (all references apply to commissioned equipment only):

.1 Documentation of all procedures performed shall be provided and forwarded to the Engineer of Record. Written documentation must contain recorded test values of all mechanical tests performed per the individual product specification.

.2 The start-up service company shall be present during energization of the mechanical equipment. Jobsite and equipment access must be provided by the Mechanical Contractor.

.3 The contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.

.4 The contractor is to attend all factory witness testing required within the respective specification sections. The contractor is responsible to cover all their costs and include them in their bid.

.5 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.6 Include the cost of commissioning in the contract price, if not yet included.

.7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.

.8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CA to facilitate the Cx process.

.9 Contractors shall provide normal cut sheets and shop drawing submittals to the CA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of pre-functional and functional testing procedures.

.1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

.2 The Commissioning Agent may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.

.10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CA for review.

.11 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

.12 Provide assistance to the CA in preparation of the specific functional performance test procedures specified in Section 23. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

.13 Develop a full start-up and checkout plan using manufacturer’s start-up procedures and the pre-functional test sheets from the CA. Submit manufacturer’s detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CA for review.

.14 During the startup and checkout process, execute and document the mechanical-related portions of the pre-functional test sheets provided by the CA for all commissioned equipment.

.15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.

.16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

.17 Perform functional performance testing under the direction of the CA for specified equipment in Part 1, Subsection 1.0. Assist the CA in interpreting the monitoring data, as necessary.

.18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, PM and A/E and retest the equipment.

.19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

.20 During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings and final as-builts for contractor-generated coordination drawings.

.21 Provide training of the Owner’s operating personnel as specified.

.22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

.23 Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.

.24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

.25 Assist and cooperate with the TAB contractor and CA by:

.1 Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.

.2 Including cost of sheaves and belts that may be required by TAB.

.3 Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.

.4 Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

.26 Install a P/T plug at each water sensor which is an input point to the control system.

.27 List and clearly identify on the as-built drawings the locations of all air-flow stations.

.28 Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.

.29 Notify the PM/GC or CA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the PM/GC or CA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.

.2 TAB Contractor: The duties of the TAB contractor, in addition to those listed in 1.2.1 are:

.1 Six weeks prior to starting TAB, submit to the PM/GC the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.

.2 Submit the outline of the TAB plan and approach for each system and component to the CA, PM/GC and the Controls Contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system. The submitted plan will include:

.1 Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.

.2 An explanation of the intended use of the building control system. The Controls Contractor will comment on feasibility of the plan.

.3 All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

.4 Discussion of what notations and markings will be made on the duct and piping drawings during the process.

.5 Final test report forms to be used.

.6 Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow strengtheners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

.7 List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

.8 Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pilot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).

.9 The identification and types of measurement instruments to be used and their most recent calibration date.

.10 Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.

.11 Confirmation that TAB understands the outside air ventilation criteria under all conditions.

.12 Details of whether and how minimum outside air cfm will be verified and set and for what level (total building, zone, etc.).

.13 Details of how building static and exhaust fan / relief damper capacity will be checked.

.14 Proposed selection points for sound measurements and sound measurement methods.

.15 Details of methods for making any specified coil or other system plant capacity measurements.

.16 Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.

.17 Details regarding specified deferred or seasonal TAB work.

.18 Details of any specified false loading of systems to complete TAB work.

.19 Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.

.20 Details of any required interstitial cavity differential pressure measurements and calculations.

.21 Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).

.22 Plan for formal progress reports (scope and frequency).

.23 Plan for formal deficiency reports (scope, frequency and distribution).

.3 A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA and PM/GC at least twice a week.

.4 Communicate in writing to the Controls Contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

.5 Provide a draft TAB report within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB.

.6 Provide the CA with any requested data, gathered, but not shown on the draft reports.

.7 Provide a final TAB report for the CA with details, as in the draft.

.8 Conduct functional performance tests and checks on the original TAB as specified for TAB in Section 23 05 93.

PART 2- PRODUCTS

2.1 Not Used

.1 Not used.

PART 3- EXECUTION

3.1 Submittals

.1 Section 23 Contractors shall provide submittal documentation relative to commissioning to the CA as requested by the CA. Refer to Section 01 91 00 Part 3.3 for additional Section 23 requirements.

3.2 Start-up of Equipment

.1 The HVAC contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 00. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

.2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre functional checklists as soon as possible.

.3 Prior to the start up of equipment the Division 23 Contractor shall arrange to have the Manufacturer of all major equipment inspect the installation to ensure their equipment has been installed in accordance with their recommendations.

.4 The Supplier shall submit a written report of their findings.

.5 Upon confirmation that the equipment has been installed in accordance with the Manufacturers Recommendations the equipment may be started.

.6 All equipment shall be started by the Manufacturer’s representative.

3.3 Pre-Functional Test Sheets

.1 Pre-functional test sheets contain items for Section 23 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer’s recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.

.2 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CA. Contractor’s assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off. “Contr.” column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = Architect/Engineer, All = all Contractors, CA = Commissioning Agent, CC = Controls Contractor, EC = Electrical Contractor, PM/GC = General Contractor, MC = Mechanical Contractor, SC = Sheet Metal Contractor, TAB = Test and Balance Contractor.

3.4 Operations and Maintenance Manuals

.1 Section 23 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 23 and deliver to the GC for inclusion in the O&M manuals

.2 The CA shall receive a copy of the O&M manuals for review.

3.5 Training of Owner Personnel

.1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01 91 00 for additional details.

.2 The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01 91 00 for additional details.

.3 Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:

.1 Provide the CA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.8.

.2 Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.

.3 Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

.4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

.5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.

.6 The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

.7 The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

.8 Training shall include:

.1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.

.2 A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.

.3 Discussion of relevant health and safety issues and concerns.

.4 Discussion of warranties and guarantees.

.5 Common troubleshooting problems and solutions.

.6 Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.

.7 Discussion of any peculiarities of equipment installation or operation.

.9 The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1-1989R, 1996 is recommended.

.10 Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

.11 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.

.12 The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.

.13 Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

3.6 Deferred Testing

.1 Refer to Section 01 91 00, Part 3.9 for requirements of deferred testing.

3.7 WRITTEN WORK PRODUCTS

.1 Written work products of Section 23 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.

1.2 References

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

1.3 Waste Management and Disposal

.1 Separate and recycle waste materials.

.2 Dispose of unused cleaning solutions at official hazardous material collections site approved by the Consultant.

.3 Do not dispose of unused cleaning solutions into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

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

.5 Dispose of corrugated cardboard polystyrene plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 - PRODUCTS

2.1 Cleaning Solutions

.1 To a minimum as follows:
.1 Tri-sodium phosphate: 0.40kg 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 Cleaning Hydronic Systems

.1 Timing
.1 Systems to be 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 to be 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 to be used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems
.1 Systems to be free from construction debris, dirt and other foreign material.
.2 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
.3 Strainers to be 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

3.1 Cleaning Hydronic Systems (Cont'd)

.6 (Cont'd)

.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 meter to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60° C 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 so as to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to maximum design 82 ^{0} C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38° 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).

3.2 Start-up of Hydronic Systems

.1 After cleaning is completed and system is filled:

.1 provide continuous supervision during start-up.

.2 Establish circulation and expansion tank level, set pressure controls.

.3 Ensure air is removed.

3.2 Start-up of Hydronic Systems (Cont'd)

.1 (Cont'd)

.4 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.5 Clean out strainers repeatedly until system is clean.

.6 Commission water treatment systems.

.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.8 Repeat with water at design temperature.

.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.10 Bring system up to design temperature and pressure slowly over a 48 hour period.

.11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing of HVAC.

.12 Adjust pipe supports, hangers, springs as necessary.

.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.14 If bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.15 Re-tighten bolts, etc. using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.16 Check operation of drain valves.

.17 Adjust valve stem packings as systems settle down.

.18 Fully open all balancing valves (except those that are factory-set).

.19 Check operation of over-temperature protection devices on circulating pumps.

.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

.21 Expansion loops:

.1 During warm-up, monitor carefully to ensure complete freedom of movement. If binding occurs, shutdown systems, re-align and repeat start-up procedures.

.22 Anchors, guides, supports:

3.2 Start-up of Hydronic Systems (Cont'd)

.1 (Cont'd)

.22 (Cont'd)

.1 Monitor at all times during start-up and commissioning to ensure operation as designed.

.2 Adjust pipe supports, hangers, springs.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:
.1 Copper piping valves and fittings for hydronic systems.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)
.1 ANSI/AWS A5.8/A5.8M:2004, Specification for Filler Metals for Brazing and Braze Welding.

.2 American Society of Mechanical Engineers (ASME)
.1 ANSI/ASME B16.4-2006, Gray Iron Threaded Fittings, Classes 125 and 250.
.2 ANSI/ASME B16.15-2006, Cast Bronze Threaded Fittings: Classes 125 and 250.
.3 ANSI/ASME B16.18-2001(R2005), Cast Copper Alloy Solder Joint Pressure Fittings.
.4 ANSI/ASME B16.22-2001(R2005), Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.3 American Society for Testing and Materials International (ASTM)
.1 ASTM B32-08, Standard Specification for Solder Metal.
.2 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
.3 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
.4 ASTM B88M-05, Standard Specification for Seamless Copper Water Tube (Metric).
.5 ASTM E202-10, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.5 Manufacturers Standardization Society (MSS)
.1 MSS SP-67-2002a, Butterfly Valves.
.2 MSS SP-70-2006, Gray Iron Gate Valves, Flanged and Threaded Ends.

1.2 REFERENCES (Cont'd)

.5 (Cont'd)

.3 MSS SP-71-2005, Gray Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS SP-80-2008, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

.1 Product Data:

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

.2 Shop Drawings:

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

.2 Indicate on manufacturers catalogue literature the following: valves.

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

.1 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals:

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

1.4 QUALITY ASSURANCE

.1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

PART 2 - PRODUCTS

2.1 TUBING

.1 Type L hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

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

.2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.

.3 Cast copper alloy solder joint pressure fittings: to ANSI/ASME B16.18.

2.3 FLANGES

.1 Provide wherever pipes of dissimilar metals are jointed.

.2 Brass or bronze: threaded.

.3 For pipe sizes 2 NPS and under, provide di-electric unions or couplings.

2.4 JOINTS

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

.2 Screwed fittings: with orange teflon tape and metallic compound pipe thread sealant.

2.5 VALVES

.1 Connections:
.1 NPS 2 and smaller: ends for soldering.
.2 NPS 2-1/2 and larger: flanged or grooved ends.

.2 Gate Valves:

2.5 VALVES (Cont'd)

.2 (Cont'd)
.1 NPS 2 and under:
.1 Mechanical Rooms: Class 125, rising stem, solid wedge disc, as specified Section 23 05 23 - Valves.
.2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23 - Valves.
.2 NPS 2-1/2 and over:
.1 Mechanical Rooms: rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23 - Valves.
.2 Elsewhere: Non- rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23 - Valves.

.3 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23 - Valves.

.4 Swing check valves:
.1 NPS 2 and under:
.1 Class 125, swing, with composition disc, as specified Section 23 05 23 - Valves.
.2 NPS 2-1/2 and over:
.1 Flanged ends: as specified Section 23 05 23 - Valves.

.5 Ball valves:
.1 NPS 2 and under: as specified Section 23 05 23 - Valves.

.6 Circuit Balancing valves (CBV):
.1 Sizes: calibrated balancing valves, as specified.
.2 NPS 2 and under:
.1 General:
.1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter.
.2 Accuracy:
.1 Readout to be within plus or minus 2% of actual flow at design flow rate.
.3 Pressure die-cast dezincification resistant copper alloy construction, Teflon disc, screw-in bonnet.

2.5 VALVES (Cont'd)

.6 (Cont'd)

.2 (Cont'd)

.1 Flow control: At least four 4 full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.

.4 Insulation:

.1 Use prefabricated shipping packaging of 5.4 R polyurethane as insulation.

.5 Drain connection:

.1 NPS 3/4 valved and capped, suitable for hose socket.

.2 Incorporated into valve body or provided as separate item.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

.1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.

.3 Slope piping in direction of drainage and for positive venting.

.4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.6 Assemble piping using fittings manufactured to ANSI standards.

.7 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.

.8 Install all pipe wells or other devices supplied by Division 23.

3.2 VALVE INSTALLATION

.1 Refer to Section 23 05 23 - Valves.

3.3 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.4 FIELD QUALITY CONTROL

.1 Testing:
.1 Test system in accordance with Section 23 05 00 - Common Work Results - Mechanical.

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

3.5 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 Section Includes.
.1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.

.2 Related Sections.
.1 Section 23 05 00 - Common Work Results - Mechanical.
.2 Section 23 05 17 - Pipe Welding.
.3 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
.4 Section 23 05 05 - Installation of Pipework.
.5 Section 23 05 23 - Valves.
.6 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
.7 Section 23 21 13.01 - Hydronic Systems: Copper.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).
.1 ANSI/ASME B16.1-2010 Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
.2 ANSI/ASME B16.3-2006, Malleable Iron Threaded Fittings: Classes 150 and 300.
.3 ANSI/ASME B16.5-2009, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
.4 ANSI/ASME B16.9-2007, Factory-Made Wrought Buttwelding Fittings.
.5 ANSI/ASME B18.2.1-2010, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
.6 ANSI/ASME B18.2.2-2010, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).

.2 American Society for Testing and Materials International, (ASTM).
.1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.

1.2 REFERENCES (Cont'd)

.2 (Cont'd)

.2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.3 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.

.4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 ASTM E202-10, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.3 American Water Works Association (AWWA).

.1 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).

.1 CSA B242-05, Groove- and Shoulder-Type Mechanical Pipe Couplings.

.2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.

.5 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).

.1 MSS SP-67-2002a, Butterfly Valves.

.2 MSS SP-70-2006, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS SP-71-2005, Cast Iron Swing Check Valves Flanged and Threaded Ends.

.4 MSS SP-80-2008, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 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 and include following:

.1 Special servicing requirements.

1.4 QUALITY ASSURANCE

.1 Health and Safety.
.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

PART 2 - PRODUCTS

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, Sch. 40, as follows:
.1 Steel piping is only allowed on closed hydronic water system NPS 2-1/2 and above.
.2 NPS 2 and under shall be copper only as per Section 23 21 13.01.

2.2 PIPE JOINTS

.1 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.

.2 Roll grooved: rigid coupling to CSA B242.

.3 Flanges: plain or raised face, weld neck to ANSI/AWWA C111/A21.11.

.4 Flange gaskets: to ANSI/AWWA C111/A21.11.

.5 Pipe thread: taper.

.6 Bolts and nuts: to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2.

.7 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ANSI/ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:
.1 Cast iron: to ANSI/ASME B16.1, Class 125.
.2 Steel: to ANSI/ASME B16.5.

.3 Butt-welding fittings: steel, to ANSI/ASME B16.9.

.4 Unions: malleable iron, to ASTM A47/A47M and ANSI/ASME B16.3.

2.3 FITTINGS (Cont'd)

.5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M, ductile iron to ASTM A536.

2.4 VALVES

.1 Connections:
.1 NPS 2-1/2 and larger: Flanged or grooved ends.

.2 Gate valves:
.1 NPS 2-1/2 and over:
.1 Mechanical Rooms: rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.
.2 Elsewhere: Non-rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.

.3 Balancing, for TAB:
.1 Refer to Section 23 21 13 - Hydronic Systems: Copper.

.4 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23 - Valves.

.5 Swing check valves: to MSS SP-71.
.1 NPS 2-1/2 and over:
.1 Flanged Grooved ends: as specified Section 23 05 23 - Valves.

.6 Butterfly valves:
.1 NPS 2-1/2 and over: grooved ends, as specified in Section 23 05 23 - Valves.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

3.2 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

3.2 CIRCUIT BALANCING VALVES (Cont'd)

.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 FILLING OF SYSTEM

.1 Refill system with clean water adding water treatment as per Section 23 25 00.

3.4 TESTING

.1 Test system in accordance with Section 23 05 00 - Common Work Results - Mechanical.

3.5 BALANCING

.1 Balance water systems to within plus or minus 5% of design output.

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
.1 ASME-2010, Boiler and Pressure Vessel Code.

.2 ASTM International Inc.
.1 ASTM A47/A47M-99(2009), 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-10, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.
.4 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
.5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 Canadian Standards Association (CSA International)
.1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code. Includes Update No.1 (2009).

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.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

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

PART 2 - PRODUCTS

2.1 MANUAL AIR VENT

.1 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 1034 kPa working pressure.

.2 Float: solid material suitable for 115 degrees C working temperature.

PART 3 - EXECUTION

3.1 GENERAL

.1 Install as indicated and to manufacturer's recommendations.

.2 Maintain adequate clearance to permit service and maintenance.

.3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.

.4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.2 STRAINERS

.1 Install in horizontal or down flow lines.

.2 Ensure clearance for removal of basket.

.3 Install ahead of each pump.

.4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.

3.3 AIR VENTS

.1 Install at high points of systems.

.2 Install ball valve on manual air vent inlet. Run discharge to nearest floor drain.

3.4 EXPANSION TANKS

.1 Adjust expansion tank pressure as indicated to suit design criteria.

.2 Install lockshield type valve at inlet to tank

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 Materials and installation of low-pressure metallic ductwork, joints and accessories.

.2 Related Sections:
.1 Section 07 84 00 - Firestopping.
.2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
.3 Section 23 05 94 - Pressure Testing of Ducted Air Systems.

1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 American Society for Testing and Materials International, (ASTM).
.1 ASTM A480/A480M-11a, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
.2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
.3 ASTM A653/A653M-10, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.3 Department of Justice Canada (Jus).
.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
.1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Association (NFPA).
.1 NFPA 90A-2009, Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.2 REFERENCES (Cont'd)

.5 (Cont'd)
.2 NFPA 90B-2009, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition 2005.
.2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
.3 SMACNA IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

.7 Transport Canada (TC).
.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 SUBMITTALS

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

.2 Indicate the following:
.1 Sealants.
.2 Tape.
.3 Proprietary Joints.

1.4 QUALITY ASSURANCE

.1 Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Protect on site stored or installed absorptive material from moisture damage.

PART 2 - PRODUCTS

2.1 SEAL

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C

.2 Seal classification:
.1 Class C: transverse joints and connections made air tight with sealant. Longitudinal seams unsealed.

2.2 SEALANT

.1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

.1 Fabrication: to SMACNA 500 Pa Class.

.2 Radiused elbows:
.1 Rectangular: Centreline radius of 1.5 times duct dimension in plane of rotation except where duct velocities are less than 4 m/s where radius may be reduced to 1 times.
.2 Round: Centreline radius of 1.5 times duct diameter except where duct velocities are less than 4 m/s where radius may be reduced to 1 times.
.3 Oval: Centreline radius of 1.5 times duct dimension in-line of rotation except where duct velocities are less than 4 m/s where radius may be reduced to 1 times.

.3 Mitred elbows, rectangular:
.1 To 400 mm: with single thickness turning vanes.
.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

2.5 FITTINGS (Cont'd)

.4 (Cont'd)

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full short radiused elbows.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.

.2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA 500 Pa Class.

.3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a Class C seal.

.4 Application: all new supply ductwork.

2.8 STAINLESS STEEL

.1 Fume hood exhaust ductwork using type 316L stainless steel sheets with longitudinal joints.

.1 Passivate and anneal SS sheets before welding. For circular ducts roll sheets circular and weld flush. Provide integral 2mm flanges on abutting ends of manufactured ducts.

2.8 STAINLESS STEEL (Cont'd)

.2 Continuously weld all joints using Inert Gas Metal Arc process without burning parent metal, using filler rods type ER316L as specified in CSA W48. Grind smooth and polish all joints.

.3 Construction:

.1 Construct ductwork from following thicknesses of stainless steel sheet.

.1 Rectangular ducts 1.3mm minimum.

.2 Circular ducts up to 500mm diameter 0.8mm minimum.

.3 Circular ducts over 500mm diameter 1.0mm minimum.

.2 Reinforce rectangular ducts with galvanized angle frames at 1200mm on centres 40 x 40 x 3mm up to 900mm maximum dimension and 50 x 50 x 6mm for larger ducts.

.4 Flexible connectors: neoprene coated glass fibre, coated both sides, secured to ducts and fans with 25 x 3mm SS type 316L flat bars or bands using type 316L SS screws or bolts at 100mm intervals.

.5 Supply SS instrument test holes or pitot type openings in horizontal ducts to permit full length internal washing of horizontal ducts, 38mm minimum diameter made from type 316L SS comprising short tube closed air and watertight by cover with cane type closing device and attaching chain. Locate openings on 1500mm centres and so that no pockets exits to hold condensate or water.

.6 Run ducts vertically between hood or canopy and duct terminal with minimum horizontal offset from risers.

2.9 HANGERS AND SUPPORTS

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

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500 mm.

.2 Hanger configuration: to SMACNA.

2.9 HANGERS AND SUPPORTS (Cont'd)

.1 (Cont'd)

.3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA or the following table (whichever is heavier construction):

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

.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 NFPA 90A, NFPA 90B and SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct.

.3 Support risers in accordance with SMACNA.

.4 Install breakaway joints in ductwork on each side of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining

3.2 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA as follows:

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

3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:
.1 Minimum 3000 mm from duct mounted humidifier in all directions.

.2 Form bottom of horizontal duct without longitudinal seams.
.1 Weld joints of bottom and side sheets.
.2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards low point. Slope header ducts down toward risers.

3.4 SEALING AND TAPING

.1 Apply sealant to outside of joint to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.5 LEAKAGE TESTS

.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Do leakage tests in sections.

.4 Make trial leakage tests as instructed to demonstrate workmanship.

3.5 LEAKAGE TESTS (Cont'd)

.5 Do not install additional ductwork until trial test has been passed.

.6 Test section minimum of 10 m long with not less than two branch takeoffs and two 90 degrees elbows.

.7 Complete test before performance insulation or concealment Work.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

1.2 PRODUCT DATA

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

.2 Indicate the following:
.1 Flexible connections.
.2 Duct access doors.
.3 Turning vanes.
.4 Instrument test ports.

.3 Submit manufacturer's installation instructions.

1.3 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.

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 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.

2.2 ACCESS DOORS IN DUCTS (Cont'd)

.3 Gaskets: neoprene.

.4 Hardware:
.1 Up to 300 x 300 mm: two sash locks complete with safety chain.
.2 301 to 450 mm: four sash locks complete with safety chain.
.3 451 to 1000 mm: piano hinge and minimum two sash locks.

2.3 TURNING VANES

.1 Factory or shop fabricated single thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.4 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.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Access doors and viewing panels:
.1 Size:
.1 600 x 600 mm for person size entry.
.2 300 x 300 mm for servicing entry.
.3 150 x 150 mm for viewing.
.4 As indicated.
.2 Locations:
.1 Fire dampers.
.2 Control dampers.
.3 Devices requiring maintenance.
.4 Locations required by code.
.5 Before and after turning vanes.
.6 At inlets and outlets of terminal units (reheat coils, etc.).
.7 Duct coils.
.8 Elsewhere as indicated.

3.1 INSTALLATION (Cont'd)

.1 (Cont'd)
.2 (Cont'd)

.2 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 In mixed air applications in locations as approved by Departmental Representative.
.3 At inlet and outlet of coils.
.4 Downstream of junctions of two converging air streams of different temperatures.
.5 And as indicated.

.3 Turning vanes:
.1 Install in accordance with recommendations of SMACNA and as indicated.

.4 Duct access:
.1 Access doors shall be provided for inspection of duct-mounted components and clearing of the duct systems. Access doors shall have positive seal and locking mechanisms.
.2 Access doors shall be located:
.1 such that any section of duct is not more than 15 m from a point of access;
.2 at the base of all main risers;
.3 before and after turning vanes;
.4 at fire, smoke and motorized dampers; and

3.1 INSTALLATION (Cont'd)

.4 (Cont'd)

.2 (Cont'd)

.5 at locations having an internally mounted piece of equipment or device.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Sheet Metal and Air Conditioning National Association (SMACNA)
.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible - 1985.

1.2 PRODUCT DATA

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

.2 Indicate the following:
.1 Performance data.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

.1 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height 300 mm.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside nylon end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: 100 mm.

2.3 MULTI-BLADED DAMPERS (Cont'd)

.4 Bearings: self-lubricating nylon.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

.7 Maximum leakage: 0.7% at 750 Pa.

.8 Provide shaft extension and standoff for insulated ducts.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install where indicated and as required to balance system.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 All dampers to be vibration free.

.6 Ensure damper operators are observable and accessible.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
.1 NFPA 90A-2009, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 Underwriters Laboratories of Canada (ULC)
.1 CAN/ULC S112-10, Standard Methods of Fire Test of Fire-Damper Assemblies.
.2 ULC CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
.3 ULC S505-1974, Fusible Links for Fire Protection Services.

1.2 PRODUCT DATA

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

.2 Indicate the following:
.1 Fire dampers.
.2 Fire stop flaps.
.3 Fusible links.
.4 Design details of break-away joints.

1.3 CLOSEOUT SUBMITTALS

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

1.4 EXTRA MATERIALS

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

.2 Provide following:
.1 6 fusible links of each type.

1.5 CERTIFICATION OF RATINGS

.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

PART 2 - PRODUCTS

2.1 FIRE DAMPERS

.1 Fire dampers: arrangement Type B or C, dynamic, listed and bear label of ULC, meet requirements of Federal Fire Commissioner and NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN/ULC S112.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.3 Top hinged: multi-blade hinged, sized to maintain full duct cross section as indicated.

.4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 Retaining angle iron frame as per damper assembly listing, on full perimeter of fire damper, on both sides of fire separation being pierced.

2.2 FIRE STOP FLAPS

.1 To be ULC listed and labelled and fire tested in accordance with ULC CAN4 S112.2.

.2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non asbestos ULC listed insulation and corrosion resistant pins and hinges.

.3 Flaps to be held open with fusible link conforming to ULC S505.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Coordinate with installer of firestopping.

.6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

.8 Fire Damper:

.1 Installation of all fire dampers shall be performed according to Manufacturers listed installation instructions. Installation instructions to be submitted to Departmental Representative with approval drawings.

.2 All fire dampers shall adhere to all requirements including but not limited to:

.1 sleeve including proper gauge thickness;

.2 retention angles and securement;

.3 damper to sleeve securement;

.4 duct to sleeve breakaway connection;

.5 clearance between opening and sleeve; and

.6 duct access door.

.3 After installation is completed, remove fusible link, operate curtain, replace fusible link after curtain is returned to open position. Curtain shall operate freely to closed position without assistance or other intervention. Test shall be witnessed by the commissioning agent.

3.1 INSTALLATION (Cont'd)

.8 (Cont'd)

.4 Installer shall certify each installation on completion of installation and curtain operation test. Certification shall be recorded and shall be turned over to Departmental Representative prior to inspection of installation.

.9 Coordinate with work of Section 23 05 93 - Testing, Adjusting and Balancing for HVAC. Repair or replace installations where required for completion of TAB contract.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 23 07 13 - Duct Insulation.

.3 Section 23 31 13 - Metal Ducts - Low Pressure to 500 Pa.

1.2 REFERENCES

.1 National Fire Protection Association (NFPA)
.1 NFPA 90A-2009, Standard for the Installation of Air-Conditioning and Ventilating Systems.
.2 NFPA 90B-2009, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 95 and Addendum No.1 1997.

.3 Underwriter's Laboratories of Canada (ULC)
.1 CAN/ULC S110-07, Standard Methods of Test for Air Ducts.
.2 UL 181-2005, Factory-Made Air Ducts and Connectors.

1.3 PRODUCT DATA

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

.2 Indicate the following:
.1 Thermal properties.
.2 Friction loss.
.3 Acoustical loss.
.4 Leakage.
.5 Fire rating.

1.4 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.

1.5 SAMPLES

.1 Submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Factory fabricated to CAN/ULC S110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50 for any portion of flexible duct including jacket.

2.2 METALLIC - INSULATED

.1 Type 2: Spiral wound flexible aluminum with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket.

.2 Performance:
.1 Factory tested to 3.0 kPa without leakage.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

.1 Install in accordance with: SMACNA.

.2 Maximum length of flexible duct: 1.5 m. Support flexible duct to prevent deforming or restricted air flows. All ductwork to diffusers including the elbow shall be rigid ductwork.

3.1 DUCT INSTALLATION (Cont'd)

.3 Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of internal diameter of duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 25 mm wide, and cover one half the circumference of the outside diameter of the flexible duct.

.4 Transverse duct joints at connections to rigid ductwork and equipment shall be sealed in accordance with Section 23 31 13.01.

.5 The ends of ducts shall be trimmed squarely prior to installation.

.6 Collars to which flexible duct is attached shall be a minimum of 50 mm in length.

.7 Collars and sleeves shall be inserted into flexible ducts a minimum of 25 mm before fastening.

.8 Metallic flexible duct shall be attached using a minimum of three #8 sheet metal screws equally spaced around the duct's circumference; ducts larger than 300 mm diameter shall have a minimum of five #8 sheet metal screws. Screws shall be located at least 12 mm from the duct end.

.9 Insulation and vapour barriers shall be fitted over the core connection and shall be supplementally secured with a draw band.

.10 Insulated metallic flexible ductwork shall be provided where ductwork is identified to be insulated under Section 23 07 13 - Duct Insulation.

.11 Flexible ductwork is not to be used for return air. Flexible ductwork may be used as described above for supply air only.

END OF SECTION

PART 1 - GENERAL

1.1 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with 23 05 00 - Common Work Results - Mechanical.

.2 Indicate the following:
.1 All dimensions.
.2 Coil Capacities.

1.2 Maintenance Data

.1 Provide maintenance data for incorporation into manual specified in Section 23 05 00 - Common Work Results - Mechanical.

1.3 Manufactured Items

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

PART 2 - PRODUCTS

2.1 Units General

.1 Field assembled factory manufactured components to form units supplying air at design conditions as indicated.

2.2 Coils

.1 General:
.1 Cleanable tube type: steel headers and straight tubes.
.2 Plate fin type: tubes mechanically bonded to fins. Spiral wound fin type: mechanically bonded to tubes. Minimum fin spacing 390 fins/m.
.3 All non-ferrous tubes and headers: brazed assembly.
.4 Maximum tube length: 3.6 m unless specified otherwise.
.5 Factory tested with air under water.

.2 Capacities: as indicated on the Drawings.

2.2 Coils (Cont'd)

.3 Ratings: ARI Certified by manufacturer.

.4 Coil casings:
.1 Mounting: designed for bolting to other sections.
.2 Steel: die formed 1.6mm thick galvanized steel sheet.
.3 Tube supports: allow for expansion and contraction.
.4 Supports: steel channel or double angle frames or other approved supports. Provide brass supports for copper coils.
.5 Air pressure drop through heating coils: .04 KPa maximum.
.6 Water velocity: 1.2m/s maximum.

PART 3 - EXECUTION

3.1 Installation

.1 Apply sealer into all seams prior to assembly. Secure toe angles on 12" centres for full length of casing.

.2 Install to manufacturer's recommendations.

.3 Install access doors in the ductwork upstream and downstream of the heating coils.

END OF SECTION

PART 1 - GENERAL

1.1 PRODUCT DATA

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

.2 Indicate the following:
- .1 Capacity.
- .2 Throw and terminal velocity.
- .3 Noise criteria.
- .4 Pressure drop.
- .5 Neck velocity.
- .6 Construction and finish.
- .7 Mounting details.

1.2 CERTIFICATIONS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

1.3 EXTRA MATERIALS

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

.2 Include:
- .1 Keys for volume control adjustment.
- .2 Keys for air flow pattern adjustment.

PART 2 - PRODUCTS

2.1 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.

.2 Frames:
- .1 Full perimeter gaskets.
- .2 Plaster frames where set into plaster or gypsum board.
- .3 Tamper proof security screws, concealed fasteners.
- .4 Security sleeves where noted.

2.1 GENERAL (Cont'd)

.3 Concealed manual volume control damper operators. Volume control dampers located in diffuser necks are not acceptable for main air system balancing, unless specifically noted otherwise. Balancing dampers shall be provided in ductwork at branch take-offs to all diffusers.

.4 Colour: as indicated in schedules on drawings and/or as directed by Departmental Representative.

.5 Confirm mounting type with architectural reflected ceiling plan.

2.2 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type to be product of one manufacturer.

2.3 SUPPLY GRILLES AND REGISTERS

.1 Type A: Steel, square 4 cone ceiling supply diffuser, adjustable air pattern, for mounting in T-bar grid, white powder coat finish. Provide safety chain from back side of diffuser to structure independent of ductwork.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Install with flat head colour matched screws in countersunk holes where fastenings are visible.

.3 All fasteners shall be tamperproof security type fasteners.

.4 Provide concealed safety chain on each grille, register and diffuser as specified.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section

1.2 REFERENCES STANDARDS

.1 American National Standards Institute (ANSI).
.1 ANSI/ASHRAE 110-1995, Method of Testing Performance of Laboratory Fume Hoods.
.2 ANSI/AIHA Z9.5-2003, Laboratory Ventilation.

.2 ASTM International (ASTM).
.1 ASTM A167 -99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
.2 ASTM A1008/A1008M - 12, Standard Specification for Steel, sheet. Cold Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
.3 ASTM B456- 11e1, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
.4 ASTM E-84 -12, Standard Test Method for Surface Burning Characteristics of Building Materials.

.3 NFPA 91 "Exhaust Systems for Air Conveying of Vapor, Gases, Mists and Non-combustible Particulate Solids.

.4 Canadian General Standards Board (CGSB).
.1 CAN/CGSB 12.1 -M90, Tempered and Laminated Safety Glass.

.5 CSA International
.1 CSA W48-06 (R2011), Filler Metals and Allied Materials for Metal Arc Welding.
.2 CAN/CSA C22.2 NO. 61010-1-04 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.

.6 National Fire Protection Association (NFPA).

1.2 REFERENCES STANDARDS (Cont'd)

.6 (Cont'd)
.1 NFPA 45-2011, Standard on Fire Protection for Laboratories Using Chemicals.

.7 National Plumbing Code of Canada 2010.

.8 Public Works and Government Services Canada (PWGSC).
.1 PWGSC MD15126 Guide for Laboratory HVAC 2012.
.2 PWGSC MD15128 2008, Laboratory Fume Hoods.
.3 PWGSC CP.1 to CP.13 2003, Commissioning Manuals and Guidelines.

.9 Underwriter Laboratories (UL).
.1 UL 723 -08, Tests for Surfaces Burning Characteristics of Building Materials.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Co-ordination: Co-ordinate work of this Section with work of other trades for proper time and sequence to avoid construction delays.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Contract Conditions and Section 01 33 00 - Submittal Procedures.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for fume hood components and accessories, including product characteristics, performance criteria, physical size, finish and limitations.
.1 Submit list of fume hood materials, components and accessories to be incorporated into Work.
.2 Include product names, types and series numbers for fume hood components and accessories.
.3 Include contact information for manufacturer for fume hood components and accessories used on this Project.
.4 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.2 (Cont'd)
.1 (Cont'd)

.3 Shop Drawings:
.1 Include on drawings:
.1 Materials and profiles and provide full-size, scaled details of components for each type of Fume Hood.
.2 Details of construction with dimensions, cross sections, and adjacent equipment.
.3 Roughing-in dimensions for plumbing, laboratory services, and electrical.

.4 Samples:
.1 Submit duplicate service fixtures with corrosion resistant finish.
.2 Submit sample of filter if used in fume hoods located in radioisotope laboratories.
.3 Submit 100mm x 100mm samples of interior and exterior surface finishes, and of work surface.
.4 Submit sample of airflow monitor/alarm.

.5 Test and Evaluation Reports:
.1 Submit detailed performance reports in accordance with PWGSC MD15128, fume hood design criteria and materials thickness. Include hood superstructure details.
.1 Indicate exhaust air flow rate.
.2 Indicate pressure drop through fume hood.

.6 Field reports: submit manufacturer's field reports within three days of manufacturer representatives' site visit.

.7 Submit detailed seismic anchorage and attachment drawings and calculations complying with requirements and regulations for seismic restraint (where applicable).

1.5 CLOSEOUT SUBMITTALS

.1 Supply operation and maintenance data for laboratory fume hood for incorporation into manual specified in Section 01 78 00 Closeout Submittals.

1.5 CLOSEOUT SUBMITTALS (Cont'd)

.1 (Cont'd)

.1 Submit information for instructions for safe and proper operation of fume hoods. Include:

.1 Written instructions booklet showing additional information on safe, proper operation and maintenance, components parts list, and nearest local manufacturer's representative for components and emergency repairs.

.2 Record Documentation:

.1 Submit list of materials used in fume hood work.

.2 Submit methodology for sealing joints.

.3 Warranty: submit warranty documents as specified.

.4 Acceptance verification check sheet.

.5 Operator Training Guide: Provide DVD with training presentation, highlighting proper operating practices of laboratory fume hood.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Supply special tool for opening sash beyond normal opening position.

1.7 QUALITY ASSURANCE

.1 Fume hood, components and accessories to be manufactured by single manufacturer.

.2 Manufacturers will only be approved for this project after verification is made of fume hood test facility at manufacturer's factory location.

.1 Testing facility to comply with ANSI/ASHRAE 110 requirements.

.2 Ensure performance data readings are digitally recorded and raw data submitted in electronic format approved by Departmental Representative.

1.7 QUALITY ASSURANCE (Cont'd)

.3 Certification: submit catalogued or published certified ratings obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying performance capabilities, including "As Manufactured (AM)" tests in accordance with PWGSC MD15128.

.4 Repeat AM tests if requested in presence of Departmental Representative.

1.8 DELIVERY STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
.1 Upon arrival and before installation, demonstrate that fume hood is consistent with prototype and product data, and has not been damaged in transit.
.2 Ensure fume hood bears CSA label.
.3 Inspect fume hood and record condition using approved check sheet.

1.9 WARRANTY

.1 Project Warranty: refer to Contract Conditions for project warranty provisions.

PART 2 - PRODUCTS

2.1 DESCRIPTION

.1 Laboratory fume hood: ventilated, enclosed work space, designed for continuous use to capture, confine and exhaust fumes, vapours and particulates generated within fume hood cavity.

.2 Factory fabricated package, piped and wired for single connections to exhaust system, electrical power, laboratory services, water supply, and laboratory drainage system.

2.1 DESCRIPTION (Cont'd)

.3 Fume hood base cabinet.

2.2 DESIGN CRITERIA

.1 Fume hood, controls and alarms: ULC labelled.

.2 Fume hood face velocity: 0.35 m/s.
.1 Design sash position (normal operating sash height): 450mm.
.2 Noise level (with sash in normal operating position) at 500 mm from sash: 70dBA maximum.

.3 Seismic: Ensure fume hood manufacturer supplies anchor bolts and templates.
.1 Ensure anchor bolts are sized to withstand seismic zone acceleration and velocity requirements for location.

.4 Meet performance criteria in PWGSC MD15128.

.5 Construct to SEFA 1 -2010 Recommended Practices for Laboratory Fume Hoods.

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS

.1 Basic Material
.1 Side and rear panels: Phenolic Resin, 0,75" (19 mm) in thickness.
.1 Screws: Exterior fastening devices: Exterior Structural Member Attachments: Sheet metal zinc plated screws and chipboard screws. Exterior panel member fastening devices shall be corrosion resistant, non-metallic material. Exposed screws are not acceptable.
.2 Back baffles: Phenolic Resin, 0,20" (5 mm) in thickness.
.1 Screws: Interior Fastening Devices: Interior fastening devices concealed. Exposed screws and screw head "caps" are not acceptable.
.3 By-Pass Grilles: Phenolic Resin, 0,2" (5 mm) in thickness.
.4 Upper front Panel: Sheet Metal 0.039" (1 mm), epoxy powder-coated.

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.1 (Cont'd)

.5 Upper Panel: 0.19" (5 mm) ESG (one pane safety glass). Tempered Option: 0.1 2".4 two pane safety lass, laminated.

.6 Lower Air Foil: Aluminum, Epoxy powder coated.

.7 Safety Glass: 0.19" (5 mm) ESG (one pane safety glass). Tempered Option: 0.1 2".4 two pane safety lass, laminated.

.8 Polycarbonate: Polycarbonate sashes only refer to Radioisotope special Hoods 0.19"(5 mm).

.9 Sash Guides: Aluminum, Epoxy powder coated.

.10 Sash Belt: Serpentine belt made of Polyurethane (PU) material, reinforced by 6 steel cables.

.11 Sash Pull: Aluminum, Epoxy powder coated.

.12 Pulley Assembly for Sash Belt: Polyamid - PA6 GK30 - ball bearing type.

.13 Baffle Support Brackets: Polybuthylene terephthalate (PBT).

.14 Duct Collar(s): Poly-phenylene sulfide (PPs), chemical resistant, heat resistant (392°F).

.15 Light Switches: Polyoxymethylene (POM) push button type, integrated in control panel.

.16 Electrical Receptacles: UL-listed: refer to project specifications.

.17 Cover Plates: Nylon.

.18 Light Fixture: UL-listed, two (2) tubes, aluminum body, shielded against fume hood interior with 0.19" one pane safety glass,T-8.

.19 All electrical wiring free of halogens (halogens are poisonous additives to e.g. PVC).

.20 Worktop: solid epoxy with raised edge or stoneware with raised edge or other as required.

.21 Support frame: Rigid metal construction made of hollow steel profiles 2.4" x 1", (vertica l) and 2.4" x 0.8 " (horizontal), Epoxy powder coated.

.22 Service Panels: Service panels being made of zinced steel, 0,75mm thick, epoxy powder coated, color: anthracite.

.23 Fume Hood Liner - Stainless steel (grade 304).

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.1 (Cont'd)

.24 Ceiling Closure Panels - Solid Phenolic Resin.

.2 Bench Fume Hood Construction

.1 A rigid, self supporting assembly of a single wall construction made of Solid Phenolic Resin. The inner interior width (interior access) of the fume hood is only 1.97" (50mm) narrower than the hood's exterior dimension.

.2 Side Wall Services Fume Hood Superstructure:

.1 Access to fixture valves, concealed in hood walls shall be provided by exterior removable access panels, access panels with gaskets on inside liner walls, or through removable front posts.

.3 Fume Hood Interior:

.1 Side walls consist of Stainless steel (grade 304), Rear walls consist of Stainless steel (grade 304).

.4 Fume Hood Walls:

.1 The side walls will be 0.75" (19mm) in thickness in order to maximize the usable interior of the fume hood.

.5 Vertical Air Foils:

.1 The vertical air foils shall be equipped with profiles in aerodynamic shape and are used to hold the display and the operational controls of the fume hood air containment control and regulation units.

.6 Service Panels:

.1 The service panels are fit into the rear wall in order to use the full width of the hood as workspace. The service panels with the installed fixtures are protected by a gasket between frame and panel. Service panels are easily removable from within the hood for maintenance. Cup sink shall be integral to the service panel and flush to the interior wall. Work surface mounted cup sink are not acceptable.

.7 Fume Hood Airfoil:

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.2 (Cont'd)

.7 (Cont'd)

.1 Opening perimeter: Air foil of streamlined shape with all right angles corners rounded or chamfered. Bottom horizontal foil shall provide nominal one inch bypass when sash is in the closed position. Bottom air foil shall be removable without tools. The bottom air foil should be made of aluminum and epoxy powder coated for durability. Steel air foils are not acceptable. The vertical air foi ls shall be equipped with profiles in ae rodynamic shape and are used to hold the display and the ope rational controls of the fume hood air c ontainment control a nd regulation units.

.8 Fume Hood Baffles:

.1 Interior fastening devices are concealed. Exposed screws and screw head caps are not acceptable. Baffles that will provide controlled air vectors into and through the fume hood shall be fabricated of the same material as the liner.

.9 Distillation lattice bar connection points:

.1 Connection points shall be integral to the rear baffles and allow for the use of distillation lattice bars without any modifications/additions or the use of tools.

.10 Fume Hood Duct Collar:

.1 10" or 12" in diameter flange type.

.11 Fume Hood Lighting:

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.2 (Cont'd)

.11 (Cont'd)

.1 Illumination: Average interior illumination levels of the work area of the fume hood shall be between 37 and 46 foot candles (400 and 500 Lux) depending on the width of the fume hood. Hood Light Fixture: Single lamp, rapid start, UL listed fluorescent light fixture installed on exterior of roof. Interior of fixture: steel, white powder-coated. Provide safety glass panel attached to the hood roof. Hoods shall be equipped with a pressure relieving system so that they can bear the over pressure resulting from an explosion. Include lamps with fixtures.

.12 Fume Hood Sash:

.1 Full frame full view type with clear, unobstructed, side-to-side view of fume hood interior and service fixture connections. The fume hood fronts shall be equipped with laminated safety glass or tempered safety glass panes so that the complete fume hood interior is visible.

.2 Sash Configurations: Combination Sash (vertical rising & horizontal sliding).

.3 An active anti-skid device and mechanical fall arrester for front sash shall be provided which immediately comes into action in any situation. The sash is designed in a way that it cannot fall down in case of a failure of the suspension device. Closing and opening of the sash does not hold any risks of injuries.

.4 The sashes are connected to their counterweights via chemically resistant toothed belts and ball bearing guide pulleys. A smooth running sash and the height detent in any position shall be guaranteed. The sash is stoppable at any position.

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.2 (Cont'd)

.12 (Cont'd)

.5 The 17.72" (450 mm) interlock of the sash must be equipped with a one-hand unlocking device in order to open the sash above that height. At the same time there must be an integral visual and acoustic alarm if the sash is opened more than 17.72" (450 mm).

.6 Set safety glass into rails in deep form. Rails to be made by extruded polypropylene.

.7 Open and close sash against rubber bumper stops.

.8 Sash sensors will be factory installed, concealed from view and capable accommodating vertical rising or combination sashes.

.13 Sash Handle:

.1 The sash handle and the frontal geometry of the work level (front air foil sill) form an aerodynamic unit to carry out a turbulence weak air introduction.

.14 Automated Sash Controller:

.1 Automatic sash control (motor-driven) for fume hood sashes shall consist of processor-controlled central unit, motor drive for opening and closing the sash, motion detector monitor and travelling photo-electric barrier for obstacle detection. Externally mounted obstacle detection devices are not permitted. The sash opening height will be the setpoint for the face velocity control system. The transmission of optical / electronic signals shall be integrated in the mechanics of the sash mounting; additional cables in the area of the sash suspension unit are not permitted. The automatic sash locking device must have an adjustable time span ranging from 20 seconds to 15 minutes. The sash shall be opened and closed via external control inputs.

.15 Instruction Plate:

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.2 (Cont'd)

.15 (Cont'd)

.1 Corrosion resistant plastic plate attached to the fume hood exterior with condensed information covering recommended locations for apparatus and accessories, baffle settings and proper use of sash.

.16 The fume hood bottom-support shall be made of a rigid steel frame and be an independent structure capable of supporting the hood without the need of cabinets.

.17 Work surfaces:

.1 The worktop material is described in the individual positions. The steel support structure is to be made of high-quality powder-coated steel. Guiding profiles are made of powder-coated aluminum.

.2 The work surface shall be independent of the hood and installed within the hood. The hood shall not sit on the work surface for ease of installation and modifications.

.3 Surfaces shall 1-1/4"in thickness and dished a nominal one-half inch to contain spills.

.18 Provide ceiling enclosure for fume hoods as required by project specification.

.19 Plumbing Services:

.1 Service Fixtures and Fittings: Color coded washers and hose nozzle outlets and valves mounted inside the fume hood and controlled from the exterior with color coded index handles.

.2 Valves: Needle point type with self-centering cone tip and seat of hardened stainless steel. Tip and seat shall be removable and replaceable.

.3 Provide piping for all service fixtures from valve to outlet - copper for air and vacuum and stainless steel for gas.

.4 Remote control handles: Black nylon four-arm handle with nylon color coded index buttons.

.5 Services: As shown on the drawings.

.20 Electrical Services:

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.2 (Cont'd)

.20 (Cont'd)

.1 Electrical Receptacles: Electrical receptacles shall be gray in color, commercial spec grade or higher and shall be UL and CSA approved. Flush plates: Gray acid resistant thermoplastic.

.21 Integral Factory Designed and Installed Safety Monitor and Alarm:

.1 Safety Monitor / Alarm System (VAV - Fume Hoods).

.1 Fume hood is equipped with a safety monitor/alarm system and a motor-driven flap, which monitors and controls the variable airflow-rate and provides audible & visual alarm if the airflow rate drops below safe levels.

.2 The Safety Monitor/Alarm System must be factory designed and installed, and will not be a third-party supplied device.

.3 Safety monitor: UL-listed, tamper proof, with all alarm circuits, electric components, external tubing, and manifold furnished complete and factory installed. The monitor shall have light emitting diode display which provides clear indication of airflow conditions.

.4 Calibration is required once the hood is installed and the hood exhaust and room supply systems are balanced. A secondary calibration shall be factory set into the alarm's memory only to determine that the alarm is functional and ready for shipment. The primary calibration must be completed in the field.

.5 Alarm signal: audible signal and a visual, red large light emitting diode:

.6 Silence push button, which disables the audible alarm, shall be accessible on the front of the safety monitor.

2.3 VARIABLE AIR VOLUME (VAV) BYPASS FUME HOODS (Cont'd)

.2 (Cont'd)

.21 (Cont'd)

.7 Provide alternate mode in which audible alarm is silenced indefinitely but visual alarm remains activated until the alarm condition is corrected.

.8 When the alarm condition is corrected and the face velocity and volume return to specified levels, the Safety Monitor shall automatically reset and begin routine monitoring.

.9 Purge button: when the purge button is depressed the control damper shall open to maximum airflow-rate.

.10 Electrical rating: 24 V AC/DC.

2.4 CLASS II, TYPE B1 BIOLOGICAL SAFETY CABINET

.1 Product Description

.1 Manufacturer shall be listed to NSF/ANSI 49 and have the NSF label affixed. Additionally, the cabinet shall be listed to UL 61010A-1 UL requirements for Laboratory Equiopment electrical safety, and shall have a UL label affixed.

.2 Cabinet shall have zoned or uniform down flow velocity profile relative to doan flow velocity over th work surface. All biologically contaminated ducts an dplenums shall be maintained under negative pressure or enclosed within a negative pressure zone.

.3 Sliding view screen of 1/4" safety (tempered or safety plate) glass shall be capable of moving to a fully closed position during shut down periods. Unit shall have audible alarm to indicate when view screen is in unsafe position. Calculated intake velocity through front sash opening shall be maintained between 100-110 fpm.

2.4 CLASS II, TYPE B1 BIOLOGICAL SAFETY CABINET (Cont'd)

.1 (Cont'd)

.4 Both exhaust and supply filters to be front loading and meet the zero-probed HEPA 99.99% efficient on all particles 0.3 micron by PAO test. Permanent screens mounted over the HEPA media are not acceptable. Equip cabinet with either a minihelic or magnehelic pressure gauge (up to 2" W.G.) to monitor supply filter loading, or a micro-processor based air flow monitoring system to do the same. Cabinet sliding view window shall be provided at a work access opening height of 8".

.5 Cabinet exterior to be constructed of #16 gauge type 304 stainless steel or cold-rolled painte dsteel. The cabinet interior to be #16 gauge type 304 stainless steel. Painted surfaces inside the work area are unacceptable. The interior stainless steel back wall may be either welded or coved. Provide radius (rounded) corners on the work surface. Removable metal air diffuser and filter protector to be provided in work area. Stainless steel adjustable leg leveler shall be provided on base stand. Base stand assembly shall be provided at a specifie work surface height of either 30" or 36" AFF.

.6 Cabinet shall be ergonomically designed providing a solid surface forearm rest. Maximum sight lines utilizing framelss window with ground polished edge. Ability to sit with proper posture having a return air plenum under the work tray of not more than 3-1/2" high and free form knee obstructions. Means for a large effective work zone having the work surface usable area no more than 5-1/2" from the cabinet face.

.7 Cabinet shall be provided with one (1) externally mounted duplex 120V outlet with drip-proof cover and circuit breaker. Provide two (2) 3/8" NPT penetrations on right side wall of work zone with service valves on both penetrations. Equip each cabinet with a fluorescent light (100 foot-candles of illumination at work surface). Cabinet shall be capable of being fitted with an optional germicidal ultra-violet (UV) light.

2.4 CLASS II, TYPE B1 BIOLOGICAL SAFETY CABINET (Cont'd)

.1 (Cont'd)

.8 Cabinet motor/blower shall be of an energy efficient design. Each cabinet model/size shall have a single motor/blower combination used in conjunction with a speed controller and damper to maximize filter loading capacity and system performance. The motor/blower shall be positioned so as to create even filter loading, thereby maximizing the life of the HEPAfilters and shall deliver more than 80% of the initial HEPA filter static pressure with no more than a 10% decrease of the total volume airflow rate/CFM. The cabinet shall combine either air flow velocity controller or constant volume controller that shall maintain airflow set-points to within ±5 FPM and automatically provide for a motor/blower volume adjustment increase of 250% minimum of the initial HEPA filter static pressure, using the NSF/ANSI 49, annex A.12 motor/blower performance test method.

.9 Cabinet to be furnished with an optional 12" diameter air-tight/gas-tight manual butterfly damper, to allow for easy decontamination of the cabinet for filter changes. Where it is required, the butterfly damper may be optionally actuated to control exhaust volume. All filters to accessible from the front of the cabinet. An optional bag-in/gab-out exhaust HEPA filter may be required. Where it is required, the bag-in/bag-out option shall be an NSF listed option and the cabinet labeled accordingly.

.10 Cabinet shall contain a control system which is either a self contained electronic module or discrete components to perform the following:

.1 Control blower motor.

.2 Monitor, display and optionally control exhaust volume via dual thermistor or pressure transducer.

.3 Control lights.

.4 Control outlets.

.5 Provide BAS interface contacts for alarm conditions, night setback, fan/blower on/off and remote override. Contacts must be BACNET compatible.

2.4 CLASS II, TYPE B1 BIOLOGICAL SAFETY CABINET (Cont'd)

.1 (Cont'd)

.10 (Cont'd)

.6 Exhaust interlock (double redundant) system that prevents operation of internal supply blower unless the exhaust volume is sufficient to provide the correct air barrier inflow velocity.

.11 Unit shall be completely factory pre-wired and have a 12' power cord. In addition, supply a 0.1 Amp form "C" contact on the blower switch to interact with a potential room control package.

.12 Unit to carry a three (3) year warranty.

.13 Utility requirements:

.1 E - 1/60/115V.

.2 V - 3/8" NPT (Drawings determine service requirement).

.3 G - 3/8" NPT (Drawings determine service requirement).

2.5 FABRICATION

.1 Do welding to CSA W48.

2.6 ACCESSORIES

.1 Heat shields: install where required to protect interior panels from radiant heat.

.1 Ensure shields are easily removable for cleaning and do not compromise safe operation of fume hood.

.2 Include automatic fire protection conforming to NFPA 45 within fume hood.

2.7 SOURCE QUALITY CONTROL

.1 "As Manufactured" Testing Equipment: to PWGSC MD15128.

.1 Data logger:

.1 Recording interval: 10 Hz or better.

.2 Memory: sufficient to allow data collection for the duration of the test.

.2 In-duct flow sensor to measure flow response:

.1 Speed: 10 Hz.

.2 Range: 95 L/s to 950 L/s.

2.7 SOURCE QUALITY CONTROL (Cont'd)

.1 (Cont'd)
.2 (Cont'd)
.3 Accuracy: ±5%.
.3 Thermal anemometer:
.1 Mounting: On stand with probe fixed at each traverse grid location.
.2 Include: averaging function over 20 second period for each location recorded for 20 seconds minimum at a rate of 1 reading/second on data logger.
.3 Accuracy:
.1 Below 0.50 m/s: ± 0.025 m/s.
.2 0.50 m/s and over: ± 5 %.
.4 Detector for tracer gas containment:
.1 Type: continuous reading.
.2 Minimum Detectable Level (MDL): 0.01 ppm.
.3 Accuracy:
.1 Concentrations below 0.1 ppm: ± 25%.
.2 Concentrations above 0.1 ppm: ± 10%.
.5 Smoke generator:
.1 Use smoke generator and diffuser complying with PWGSC MD15128.

.2 Conduct "as manufactured" (AM) tests in manufacturer's testing facility to ANSI/ASHRAE 110 and PWGSC 15128 procedures before transportation to site.

.3 Ensure tests achieve performance criteria in accordance with PWGSC MD15128.

.4 Coordinate with controls manufacturer for transportation of all relevant controls to fume hood manufacturer for installation and calibration to function as specified. Controls to include, but not limited to:
.1 fume hood monitor/alarm
.2 laboratory controller, with software and hardware
.3 exhaust valve and flow station
.4 sash position sensor

.5 Conduct "AM" tests as follows:
.1 With fume hood empty.
.2 With fume hood loaded to simulate apparatus in hood.

2.7 SOURCE QUALITY CONTROL (Cont'd)

.5 (Cont'd)
.2 (Cont'd)
.1 Locate simulated apparatus 150 - 250 mm behind plane of sash in manner approved by Departmental Representative as follows:
.1 1 - 3.8 litre paint can.
.2 1 - 300 x 300 x 450 mm cardboard box.
.3 4 - 150 x 150 x 300 mm cardboard boxes.
.3 With simulated cross-draft: Challenge with 0.25 m/s cross draft, using 620 mm recirculation fan under conditions as follows:
.1 Air directed horizontally at 45 degrees to plane of sash.

.6 Witnessing "AM" Tests:
.1 Perform "AM" tests in presence of Departmental Representative.
.2 Notify Departmental Representative two weeks minimum before start of testing.

.7 Conduct "As Manufactured" (AM) Fume Hood Performance Tests as follow:
.1 Visualization (smoke) tests: meet or exceed performance criteria of PWGSC MD15128.
.2 Face velocity and flow response tests: to PWGSC MD15128 and ANSI/ASHRAE 110.
.1 Average face velocity: 0.35 m/s, with variation allowed for individual readings: maximum ± 20%.
.2 VAV average face velocity with sash at 66% of design sash position: 0.35m/s ± 0.025m/s.
.1 Variation allowed for individual readings: ±20%.
.3 VAV average face velocity with sash at 33% of design sash position: 0.35m/s ±0.025m/s.
.1 Variation allowed for individual readings: ±20%.4 VAV response time: time to reach 90% of the steady state value: within 5 seconds.

.8 Test for VAV minimum flow with sash closed: to ANSI/AIHA Z9.5 capable of maintaining 375 air changes per hour.

2.7 SOURCE QUALITY CONTROL (Cont'd)

.8 (Cont'd)

.1 Tracer gas tests: to PWGSC MD15128.

.1 Conduct tests at target average face velocity.

.2 Use approved tracer gas.

.3 Perform tests with probe at height of 560 mm above work surface.

.4 Leakage with sash at normal operating position:

.1 Average leakage: 0.025 ppm maximum.

.2 Peak reading: 0.100 ppm.

.5 Leakage with sash in fully open position:

.1 Average leakage: 0.05 ppm maximum.

.2 Peak reading: 0.25 ppm.

.6 Peripheral scan:

.1 Record significant peak readings and their locations.

.2 Record 30 second rolling averages.

.3 Maximum 0.25ppm for any 30 second rolling average.

.4 Include readings in test report.

.7 Sash movement effect (SME), to determine potential for escape after movement of sash to ANSI/ASHRAE 110 procedures;

.1 Maximum 45 second rolling average:0.05}ppm.

.2 Conduct VAV Response Tests, Stability Tests and SME simultaneously for VAV fume hoods.

2.8 CONTROLS

.1 All controls and monitoring must be compatible to existing BACNET BAS.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for fume hood installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

.1 Install plumb, with work surface level to within 1.5 mm in 3000 mm by adjusting base unit levelling screws.

.2 Secure fume hood to base furniture using stainless steel fasteners spaced at 750 mm maximum on centre maximum, three minimum per side.
.1 Use four minimum for each fume hood.

.3 Secure fume hood to meet seismic criteria.

.4 Connect plumbing, laboratory services, electrical services, exhaust system, and BAS to fume hood.

.5 Install to SEFA 2 - 2010 Recommended Practices for Installations.

3.3 FUME HOOD SYSTEM INTEGRATION - GENERAL REQUIREMENTS

.1 General Requirements: Fully integrate fume hood exhaust systems into laboratory HVAC system and into BAS in order to maintain specified specified pressurization requirements and to maintain fume hood performance.
.1 Minimum Air Flow with sash closed: to ANSI Z9.5.

3.3 FUME HOOD SYSTEM INTEGRATION - GENERAL REQUIREMENTS (Cont'd)

.2 Operating Modes:
.1 Occupied - in use: generation of hazardous products occurring.
.2 Occupied - not in use: as when apparatus is being assembled.
.3 Unoccupied - in use: generation of hazardous products occurring while fume hood is unattended. Sash is closed.
.4 Standby: fume hood not in use: no active generation of hazardous products, Minimum air flow. Sash closed.

.3 Fume Hood System Integration with Dedicated Exhaust Fan:
.1 No local control of exhaust fan permitted.
.2 Ensure exhaust fan does not shut down except when fume hood is decommissioned, for apparatus assembly or for service procedures.

.4 Monitor:
.1 Green light to indicate "power on" and "safe to operate".
.2 Audible and visual alarms: Horn, buzzer or bell and red light to indicate air velocity out of range and "not safe to operate".
.1 Use fume hood only when safety controls are satisfied.
.2 Override audible alarm using silencing relay switch (red light to remain on) until abnormal condition is rectified.
.3 Reset alarm system automatically when safe conditions restored.
.3 Ensure complete operating instructions for alarm system are secured to fume hood.
.4 Interlock fume hood exhaust system with HVAC system.
.1 Ensure fume hood exhaust fan continues to run upon activation of building fire alarm system.

.5 Fume Hood System Integration with Dual Speed Exhaust Fan Control System:
.1 Fume hood exhaust fan operation switch: LOW/HIGH switch flush mounted in weatherproof box in exterior panel, with protective cover and clearly labelled.

3.3 FUME HOOD SYSTEM INTEGRATION - GENERAL REQUIREMENTS (Cont'd)

.5 (Cont'd)

.2 Operate on high speed when fume hood is in use.

.1 Monitor green light to indicate "fume hood ready for use".

.3 Operate on low speed when fume hood is not in use.

.1 Monitor red light to indicate "fume hood unsafe for use".

.6 Fume hood System Integration with Manifolded Fume Hood Exhaust System:

.1 No local control of exhaust fans permitted.

.2 Monitor:

.1 Green light to indicate "power on" and "safe to operate".

.3 Audible and visual alarms: Horn, buzzer or bell and red light to indicate air velocity out of range and "not safe to operate".

.1 Use fume hood only when safety controls are satisfied.

.2 Override audible alarm using silencing relay switch (red light to remain on) until abnormal condition is rectified.

.3 Reset alarm system automatically when safe conditions restored.

.4 Ensure complete operating instructions for alarm system are secured to fume hood.

.5 Interlock fume hood exhaust system with HVAC system.

.1 Ensure fume hood exhaust system continues to run upon activation of building fire alarm system.

3.4 ADJUSTING

.1 Adjust operable hardware for correct function.

.2 Ensure sash does not bind while opening and closing.

3.5 FIELD QUALITY

.1 Field Tests:

3.5 FIELD QUALITY CONTROL (Cont'd)

.1 (Cont'd)

.1 Conduct mock-up and integrated "as installed" (AI) tests in accordance with Section 23 05 93.13 - Testing, Adjusting and Balancing of Fume Hoods.

.2 Field Inspection: Co-ordinate field inspection in accordance with Section 01 45 00 Quality Control.

.3 Manufacturetr's Services:

.1 Coordinate manufacturer's services with Section 01 45 00 - Quality Control.

.1 Have manufacturer review work involved in handling, installation, protection, and cleaning of fume hood components and accessories, and submit written reports in acceptable format to verify compliance of Work with Contract conditions.

.2 Manufacturer's Field Services: Include manufacturer's field services consisting of product use recommendations and periodic site visits for product installation review in accordance with manufacturer's instructions.

.1 Report inconsistencies from manufacturer's recommendations immediately to Departmental Representative.

.3 Schedule site visits to review work at stages listed:

.1 After delivery and storage of fume hood components and accessories, and when preparatory work on which Work of this Section depends is complete, but before installation begins.

.2 Twice during progress of work at 25% and 60% complete.

.3 Upon completion of Work, after cleaning is carried out.

.4 Obtain reports within three days of review and submit immediately to Departmental Representative.

3.6 COMMISSIONING TESTS FOR INTEGRATED FUME HOOD SYSTEMS

.1 Do commissioning tests in accordance with Section 01 91 00 - General Commissioning Requirements and PWGSC CP.1 to CP.13.

3.6 COMMISSIONING TESTS FOR INTEGRATED FUME HOOD SYSTEMS (Cont'd)

.2 Test fume hoods in conjunction with complete laboratory integrated HVAC and exhaust systems commissioning testing including, room air flow patterns, temperature, humidity, pressurization, noise, and vibration.

3.7 CLEANING

.1 Progress Cleaning: cleaning 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.

3.8 PROTECTION

.1 Protect installed fume hood, components and accessories from damage during construction.

.2 Repair damage to adjacent materials caused by fume hood installation.

END OF SECTION

PART 1 - GENERAL

1.1 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Indicate the following:
.1 Capacity.
.2 Pressure drop.
.3 Dimensions.

1.2 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into manual specified in Section 01 33 00 - Submittal Procedures.

1.3 MANUFACTURED ITEMS

.1 Cooling coils shall be product of one manufacturer.

PART 2 - PRODUCTS

2.1 COOLING COIL

.1 All cooling coils shall be furnished to meet the performance requirements set forth in the schedule.

.2 All water coils shall have performance certified in accordance with ARI Standard 410 for coil capacity and pressure drop.

.3 All coils must be circuited to operate at design load with water velocity within the ARI range of certified rating conditions.

.4 Coil segment side and top panels shall be removable to allow for removal and replacement of coils, without affecting structural integrity.

.5 Upstream and downstream segment door clearances shall accommodate a minimum NPS 2 of field installed external piping insulation.

2.1 COOLING COIL (Cont'd)

.6 Cooling Coil Segment shall be provided with a full-width, multi-sloped (IAQ) drain pan that extends downstream a minimum NPS 6 beyond the last coil in the section to provide drain pan access for cleaning and inspection.

.7 Drain pan design and application shall comply fully with the stated intent of ASHRAE 62-2010.

.8 Drain pans shall be sloped in a minimum of 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. A minimum of NPS 1 clearance shall be provided from the bottom of the coil casing to the drain pan so that the drain pan can be visually inspected and physically cleaned, including underneath coil, without removal of the coil. All drain pan connections will be to one side of the unit to enable proper trapping. Drain pans that do not comply with these maintenance requirements will be the responsibility of the contractor to field modify.

.9 The drain pan shall be of double wall construction with a minimum stainless steel linner and shall be insulated with spray-injected foam to completely seal the drain pan assembly. Fiberglass insulation is not acceptable.

.10 The drain pan liner shall be of double wall construction of 16 gauge stainless steel and shall be fully insulated with spray injected foam, completely sealing the drain pan assembly.

.11 Drain pan shall be provided with a minimum NPS 1¼ MPT condensate connection positioned beneath the lowest point of the drain pan. Drain connection shall be welded to the drain pan and shall match the drain pan liner material type. If threaded screw-type joint is used, all joints must be easily accessible for inspection and service.

.12 All coils shall be slide out, "shipping" type, mounted on tracks, and easily removable from the ductwork.

2.1 COOLING COIL (Cont'd)

.13 Coils shall be supported by galvanized coil support members, constructed of channeled members, allowing uninhibited access for inspection and safe cleaning.

.14 All vertical coil supporting members (bulkheads) and block offs shall be constructed of galvanized steel and shall entirely seal off the coil, preventing air bypass.

.15 Coil grommets shall be provided on all coils to completely seal the area between the coil connection and the unit casing.

.16 Drainable Water coils shall be designed to operate at 250 psig design working pressure and up to 300°F and shall be tested with 325 psig compressed air under water. Circuiting shall provide free and complete draining and venting when installed in the unit. All vent and drain connections shall be extended to the outside of the unit casing.

.17 The primary surface shall be ½" O.D. copper tube, staggered in direction of airflow. Tubes shall be mandrel expanded to form fin bond and provide burnished, work-hardened interior surface. The tubes shall have a minimum tube wall thickness of .016" for ½" O.D. coils. Specified thickness shall be maintained throughout the tube including brazed U-bends.

.18 The fins shall have fully drawn collars to accurately space fins, and to form a protective sheath for the primary surface. The fin thickness shall be .006" Aluminum.

.19 Headers shall be of heavy seamless copper tubing, silver-brazed to tubes. Connections shall be of steel, with male pipe threads, tig welded to the headers. A ¼" FPT, plugged vent or drain tap shall be provided on each connection. All vent and drain connections shall be extended to the outside of the unit casing.

2.1 COOLING COIL (Cont'd)

.20 Circuiting shall be to provide free draining and venting, through one vent and one drain on each coil, when installed with casing level. Coils shall be circuited, and have connections arranged, for counter-flow of air and water with supply on bottom and return on top of coil headers. Coil circuiting shall provide for design water velocity in tubes without exceeding total water pressure drops in schedule.

.21 Coils using turbulators are unacceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verify that new coils will fit space provided.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Ensure adequate clearance for servicing and maintenance.

.3 Install access doors in the ductwork upstream and downstream of cooling coils.

3.3 MANUFACTURER'S FIELD SERVICES

.1 Manufacturer shall furnish a factory trained service engineer without additional charge to start the units.

.2 Manufacturer to:
.1 Start-up and commission installation.
.2 Demonstrate operation and maintenance to Owner's personnel.
.3 Certify installation.
.4 The above items must be completed before Substantial Performance can be issued.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 01 91 00 - Commissioning - General Requirements.

.2 Section 23 31 13 - Metal Ducts - Low Pressure to 500 Pa.

1.2 REFERENCES

.1 Canadian Standards Association (CSA).

.2 Underwriter's Laboratories of Canada (ULC).

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Indicate the following:
.1 Capacity.
.2 Construction.
.3 Control interface.

1.4 CLOSEOUT SUBMITTALS

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

1.5 EXTRA MATERIALS

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

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.

1.6 MANUFACTURED ITEMS

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

PART 2 - PRODUCTS

2.1 PACKAGED ELECTRODE STEAM GENERATING TYPE

.1 CSA certified and ULC listed.

.2 Components housed in factory fabricated cabinet with factory enamelled finish. Unit complete with factory fabricated wall brackets.

.3 Probe style water level control compatible with local water conditions.

.4 Large perforated strainer at drain outlet to prevent blockage of drain valve or drain lines.

.5 Automatic drain adjustable for duration and frequency. Provide automatic drain water tempering system to limit temperature of discharge.

.6 High water sensor circuitry to prevent over filling. Drain through bottom.

.7 Incoloy sheathed heating elements designed to shed mineral scale. Heating elements shall be removable for replacement.

.8 Access cover for service of evaporating chamber shall be operable without use of tools.

.9 Cleanout tray for periodic removal of sediment from evaporator chamber.

.10 Controls to consist of:
.1 Solid state panel with solid state relay.
.2 Solenoid valves on water fill, drain lines and drain cooler.
.3 Real time clock/timer.

2.1 PACKAGED ELECTRODE STEAM GENERATING TYPE (Cont'd)

.10 (Cont'd)
.4 User input keypad.
.5 Tank temperature sensor.
.6 Modulating, time-proportional with operating and high limit humidistats.
.7 Provide the following termination for remote BACS control points:
.1 Humidifier Enable/Disable.
.2 Humidifier modulating output.
.3 Humidifier Fault/Alarm.

.11 Direct space/room humidification includes blower pack, integral steam distribution, adjustable tube axial fans, fusing and safety circuitry. Blower pack capable of remote mounting.

.12 Power requirements: 600 V, 3 Phase, 60 Hz.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Humidifier and evaporator media to be new and clean when project is accepted.

.3 Water service overflow drain: to manufacturers' recommendation.

3.2 START-UP

.1 General: In accordance with Section 01 91 00 - Commissioning General Requirements, supplemented as specified herein.

.2 Verify:
.1 Steam lines are sloped to ensure steam condensate is drained away from the humidifier.
.2 Vapour lines and manifolds are sloped to ensure condensate is drained away from the humidifier.
.3 Visually check distribution unit to ensure:
.1 Even distribution of vapour and property steam absorption.

3.2 START-UP (Cont'd)

.2 (Cont'd)

.3 (Cont'd)

.2 Freedom from water deposits and proper condensate draining.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Methods and procedures for start-up, verification and commissioning, for Building Automation and Control System (BACS) and includes:
.1 Start-up testing and verification of systems.
.2 Check out demonstration or proper operation of components.
.3 On-site operational tests.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 00 - Closeout Submittals.

.3 Section 01 91 00 - Commissioning - General Requirements.

.4 Section 01 79 00 - Demonstration and Training.

.5 Section 25 05 01 - BACS: General Requirements.

1.3 DEFINITIONS

.1 For additional acronyms and definitions refer to Section 25 05 01 - BACS: General Requirements.

1.4 DESIGN REQUIREMENTS

.1 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.5 SUBMITTALS

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

.2 Final Report: submit report to Departmental Representative.
.1 Include measurements, final settings and certified test results.

1.5 SUBMITTALS (Cont'd)

.2 (Cont'd)
.2 Bear signature of commissioning technician and supervisor.

.3 Report format to be approved by Departmental Representative before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to BACS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.6 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.7 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system.

.2 Instrumentation accuracy tolerances : higher order of magnitude than equipment or system being tested.

.3 Locations to be approved, readily accessible and readable.

2.1 EQUIPMENT (Cont'd)

.4 Application: to conform to normal industry standards.

PART 3 - EXECUTION

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Debug system software.

.3 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.4 Test emergency and life safety procedures including operation and integrity of refuge systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.
.1 General: consists of field tests of equipment just prior to installation.
.2 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
.3 Additional instruments to include:
.1 DP transmitters.
.2 DP switches used for dirty filter indication and fan status.
.4 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source.
.5 After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.
.6 DP switches to open and close within 2% of setpoint.

.2 Completion Testing.
.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

3.2 FIELD QUALITY CONTROL (Cont'd)

.2 (Cont'd)

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.11 Blow out flow measuring and static pressure stations with high pressure air.

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Commissioning Manager and provide:

.1 Technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Commissioning to commence during final startup testing.

.4 O&M personnel to assist in commissioning procedures as part of training.

.5 Commissioning to be supervised by qualified supervisory personnel.

.6 Operate systems as long as necessary to commission entire project.

3.2 FIELD QUALITY CONTROL (Cont'd)

.2 (Cont'd)

.3 (Cont'd)

.7 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that BACS functions in accordance with contract requirements.

.1 Prior to beginning of 20 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 20 consecutive 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 BACS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

3.3 ADJUSTING

.1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

.1 Demonstrate to Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes.
.1 Requirements and procedures for training program, instructors and training materials, for Building Automation and Control System (BACS) Work.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 91 00 - Commissioning - General Requirements.

.3 Section 25 05 01 - BACS: General Requirements.

1.3 DEFINITIONS

.1 CDL - Control Description Logic.

.2 For additional acronyms and definitions refer to Section 25 05 01 - BACS: General Requirements.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.
.1 List name of trainer, and type of visual and audio aids to be used.
.2 Show co-ordinated interface with other BACS mechanical and electrical training programs.

.3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.5 QUALITY ASSURANCE

.1 Provide competent instructors thoroughly familiar with aspects of BACS installed in facility.

.2 Departmental Representative reserves right to approve instructors.

1.6 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of BACS installed.

.2 Training to be project-specific.

.3 Training shall be done as per requirements of Section 01 91 00 - Commissioning - General Requirements.

1.7 TIME FOR INSTRUCTION

.1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.8 TRAINING MATERIALS

.1 Provide equipment, visual and audio aids, and materials for classroom training.

.2 Supply manual for each trainee, describing in detail data included in each training program.
.1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.9 TRAINING PROGRAM

.1 To be in 2 phases over 6 month period.

.2 Phase 1: 1 day program to begin before 20 day test period at time mutually agreeable to Contractor, Departmental Representative and Commissioning Manager.
.1 Train O&M personnel in functional operations and procedures to be employed for system operation.

1.9 TRAINING PROGRAM (Cont'd)

.2 (Cont'd)

.2 Supplement with on-the-job training during 20 day test period.

.3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.

.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.3 Phase 2: 1 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.

.1 Provide multiple instructors on pre-arranged schedule. Include at least following:

.1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.

1.10 ADDITIONAL TRAINING

.1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.11 MONITORING OF TRAINING

.1 Departmental Representative to monitor training program and may modify schedule and content.

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 American National Standards Institute (ANSI)
.1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
.2 IEEE 260.1-2004, IEEE Standards Letter Symbols for Units of Measurement (SI Customary Inch-Pound Units, and Certain Other Units).

.2 Canadian Standards Association (CSA)
.1 CSA C22.2 NO. 0-2010, General Requirements - Canadian Electrical Code, Part II.
.2 CAN/CSA Z234.1-00(R2006), Metric Practice Guide.

1.2 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

.1 Acronyms used in BACS.
.1 AI - Analog Input
.2 AO - Analog Output
.3 BACnet - Building Automation and Control Network
.4 BACS - Building Automation and Control System.
.5 BSCS - Building Services Control System
.6 CAD - Computer Aided Design
.7 CDL - Control Description Logic
.8 COSV - Change of State or Value
.9 CPU - Central Processing Unit
.10 DI - Digital Input
.11 DO - Digital Output
.12 ECU - Equipment Control Unit
.13 HVAC - Heating, Ventilation, Air Conditioning
.14 IDE - Interface Device Equipment
.15 I/O - Input/Output
.16 ISA - Industry Standard Architecture
.17 LAN - Local Area Network
.18 LCU - Local Control Unit
.19 LonTalk - Echelon Corporation (proprietary protocol)
.20 MCU - Master Control Unit
.21 OS - Operating System
.22 O&M - Operation and Maintenance
.23 OWS - Operator Work Station
.24 PC - Personal Computer
.25 PCI - Peripheral Control Interface

1.2 ACRONYMS, ABBREVIATIONS AND DEFINITIONS (Cont'd)

.1 (Cont'd)

.26 PCMCIA - Personal Computer Micro-Card Interface Adapter
.27 RAM - Random Access Memory
.28 ROM - Read Only Memory
.29 TCU - Terminal Control Unit
.30 USB - Universal Serial Bus
.31 UPS - Uninterruptible Power Supply

.2 Definitions:

.1 Point: a point may be logical or physical. Logical points are values calculated by system such as totals, counts, derived corrections i.e. as result of and/or statements in CDL's. Physical points are inputs or outputs which have hardware wired to controllers which are measuring or providing status conditions of contacts or relays providing interaction with related equipment (stop, start) or valve or damper actuators.

.3 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA 5.5.

.1 Printouts: to IEEE 260.1.

1.3 PERMITS AND FEES

.1 In accordance with General Conditions of Contract.

1.4 GENERAL DESCRIPTION

.1 Refer to control schematics and system descriptions for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Building Controllers.
.2 Control devices as listed in I/O Summaries.
.3 OWS.
.4 Data communications equipment necessary to effect a BACS data transmission system including gateway and LAN hardware and software for connection to BACnet network.
.5 Field control devices.
.6 Software complete with full documentation for software and equipment.

1.4 GENERAL DESCRIPTION (Cont'd)

.2 (Cont'd)

.7 Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.

.8 Acceptance tests, technical support during commissioning, full documentation.

.9 Wiring interface co-ordination of equipment supplied by others.

.10 Miscellaneous work as specified in these sections and as indicated.

1.5 METRIC REFERENCES

.1 Conform to CAN/CSA Z234.1.

.2 Provide required adapters between Metric and Imperial components.

1.6 STANDARDS COMPLIANCE

.1 All equipment and material to be from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.

.4 For materials whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.7 SYSTEM INTEROPERABILITY

.1 New control system to communicate seamlessly with the existing building automation system already present on site with the use of open protocols such as BACNet. The BACS system shall also share the same operating platform and operator workstation as the existing control system.

1.8 SYSTEM DESIGN RESPONSIBILITY

.1 Design and provide all conduit and wiring linking all elements of system, including future capability.

.2 Supply sufficient programmable controllers of all types to meet project requirements. Quantity and points contents to be approved by Departmental Representative prior to installation.

.3 Location of controllers to be approved by Departmental Representative prior to installation.

.4 Provide utility power to controllers.

1.9 LANGUAGE OPERATING REQUIREMENTS

.1 Operator to interface to system in English.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. All other information to be in English.

.3 Operating system executive: primary hardware-to-software interface (specified as part of hardware purchase) with associated documentation to be in English.

.4 System manager software: to include system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency. These functions to be in English.

.5 BACS operator: include, in English:

1.9 LANGUAGE OPERATING REQUIREMENTS (Cont'd)

.5 (Cont'd)

.1 All input and output commands and messages from operator-initiated functions and/or field related changes and/or alarms as defined in CDL's or assigned limits (i.e. all commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at all specified OWS. Point name expansions in English.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.10 MATERIALS DELIVERY SCHEDULE

.1 Provide Departmental Representative with "Materials Delivery Schedule" within 2 weeks after award of Contract.

1.11 BSCS/EMCS INTERFACE

.1 BACS contractor shall interface with BSCS contractor in order to complete control functions.

.2 Refer to appropriate sections for control descriptions.

.3 BSCS contractor shall provide interface panel at location shown on drawings. Interface shall include dry contacts (NO & NC) rated at 25 V, 60 Hz, 10 A for each interface condition.

.4 It shall be the responsibility of the BACS contractor to complete systems between contacts and controlled equipment. The BACS contractor shall fully commission their work in conjunction with the BSCS contractor to ensure and prove correct operation of interfaced systems.

PART 2 PRODUCTS

2.1 LOCKABLE PANELS

.1 Panel to be NEMA rated to suit environmental requirements.

.2 To have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.

PART 3 EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 PAINTING

.1 Painting to be in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:

.2 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.3 Restore to new condition, finished surfaces which have been damaged too extensively to be primed and touched up to make good.

.4 Clean and prime exposed hangers, racks, fastenings, and other support components.

.5 Paint all unfinished equipment installed indoors to CEMA 2Y.1.

3.3 OPERATOR INSTRUCTION

.1 During and after system commissioning this Trade shall provide on-site operator instruction to the Owner's operating personnel. Operation instruction during normal working hours shall be performed by competent representatives familiar with the installed system.

3.3 OPERATOR INSTRUCTION (Cont'd)

.2 At a time mutually agreed upon with the Owner the Control Contractor shall give eighteen (18) hours of instructions to up to five (5) of the owner's designated personnel on the operation of all equipment in the system and describe its intended use.

.3 Training to be accomplished as follows:
.1 Initial instruction period - 2 days at 6 hours each.
.2 Followed by two (2) - three (3) hour instruction periods within the maintenance period at a date requested by the Owner.
.3 Record attendance log for each training period and submit to Departmental Representative.

.4 An Owner's Manual, prepared for the project by the Control Contractor shall be used during instruction. Copies of the Owner's Manual shall be provided to the Owner with Operation and Maintenance Manuals.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes.
.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for Building Automatic and Control System (BACS).

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 05 01 - BACS: General Requirements.

.3 Section 25 01 11 - BACS: Start-up, Verification and Commissioning.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 - BACS: General Requirements.

1.4 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information.
.1 Names of sub-contractors and site-specific key personnel.
.2 Sketch of site-specific system architecture.
.3 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
.4 Descriptive brochures.
.5 Sample CDL and graphics (systems schematics).
.6 Response time for each type of command and report.
.7 Item-by-item statement of compliance.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Shop Drawings to consist of 10 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

.3 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.4 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.6 DETAIL SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Complete Point Name Lists.

.5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

.6 Software and programming details associated with each point.

1.6 DETAIL SHOP DRAWING REVIEW (Cont'd)

.1 (Cont'd)

.5 (Cont'd)

.7 Manufacturer's recommended installation instructions and procedures.

.8 Input and output signal levels or pressures where new system ties into existing control equipment.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of BACS.

.7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, as specified.

.8 Listing and example of specified reports.

.9 Listing of time of day schedules.

.10 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.11 Type and size of memory with statement of spare memory capacity.

.12 Full description of software programs provided.

.13 All controllers installed must indicate that they are BACnet compatible and be BACnet Testing Lab (BTL) approved.

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 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for Building Automation and Control System (BACS) Work.

1.2 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - BACS: General Requirements.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Submittals, supplemented and modified by requirements of this Section.

.2 Submit Operation and Maintenance Manual to Departmental Representative in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
.1 Binders to be 2/3 maximum full.
.2 Provide index to full volume in each binder.
.3 Identify contents of each manual on cover and spine.

.4 Provide Table of Contents in each manual.

.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.4 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - BACS: Submittals and Review Process and include:

1.4 AS-BUILTS (Cont'd)

.1 (Cont'd)

.1 Changes to contract documents as well as addenda and contract extras.

.2 Changes to interface wiring.

.3 Routing of conduit, wiring and control air lines associated with BACS installation.

.4 Locations of obscure devices to be indicated on drawings.

.5 Listing of alarm messages.

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - BACS: Start-Up, Verification and Commissioning.

.9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Departmental Representative.

.3 Provide before acceptance 5 hard and 1 soft copy incorporating changes made during final review.

1.5 O&M MANUALS

.1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide 4 complete sets of hard and soft copies prior to system or equipment tests

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:

1.5 O&M MANUALS (Cont'd)

.4 (Cont'd)

.1 Functional description of theory of operation.

.2 Design philosophy.

.3 Specific functions of design philosophy and system.

.4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented for implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.

1.5 O&M MANUALS (Cont'd)

.6 (Cont'd)

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

.7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.

.8 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

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 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for Building Automation and Control System (BACS) Work and nameplates materials, colours and lettering sizes.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 05 01 - BACS: General Requirements.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA C22.1-09, Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations, Includes Update No. 1 (July 2010).

1.4 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - BACS: General Requirements.

1.5 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.6 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

PART 2 - PRODUCTS

2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, white.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high.

.4 Data to include: point name and point address.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Departmental Representative.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of BACS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of BACS" as reviewed by Departmental Representatives.

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each BACS panel.

2.6 CONDUIT

.1 Colour code BACS conduit. Colour code to be coordinated with Electrical Division to avoid colour code conflicts and where already established, match existing site colour coding.

.2 Pre-paint box covers and conduit fittings.

PART 3 - EXECUTION

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing nameplates and legends to reflect changes made during Work.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes.
.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for Building Automation and Control System (BACS).
.2 References.
.1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
.2 Canadian Standards Association (CSA International).
.3 CSA Z204-94(R1999), Guideline for Managing Indoor Air Quality in Office Buildings.

1.2 DEFINITIONS

.1 BC(s) - Building Controller(s).

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - BACS: General Requirements.

1.3 SUBMITTALS

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

.2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.

.3 Submit detailed inspection reports to Departmental Representative.

.4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
.1 Point name and location.
.2 Device type and range.
.3 Measured value.
.4 System displayed value.
.5 Calibration detail
.6 Indication if adjustment required,
.7 Other action taken or recommended.

1.3 SUBMITTALS (Cont'd)

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
.1 Maintain records and logs of each maintenance task on site.
.2 Organize cumulative records for each major component and for entire BACS chronologically.
.3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to BACS made during warranty period.

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain BACS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:
.1 Initiate service calls when BACS is not functioning correctly.
.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
.3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
.4 Service personnel to be on site ready to service BACS within 2 hours after receiving request for service.
.5 Perform Work continuously until BACS restored to reliable operating condition.

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD (Cont'd)

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of BACS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:
.1 Serial number identifying component involved.
.2 Location, date and time call received.
.3 Nature of trouble.
.4 Names of personnel assigned.
.5 Instructions of work to be done.
.6 Amount and nature of materials used.
.7 Time and date work started.
.8 Time and date of completion.
Provide system modifications in writing.

.5 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article. Contractor to provide schedule with close-out documents for above inspections.

.2 Perform inspections during regular working hours, 0800 to 1630 hours, Monday through Friday, excluding statutory holidays.

3.1 FIELD QUALITY CONTROL (Cont'd)

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check and calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204.

.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.

.2 Check equipment cooling fans as required.

.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.

.4 Review system performance with Departmental Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.

.5 Provide mechanical adjustments, and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.

3.1 FIELD QUALITY CONTROL (Cont'd)

.5 (Cont'd)

.7 (Cont'd)

.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.

.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

PART 1 GENERAL

1.1 NOT USED

PART 2 PRODUCTS

2.1 GENERAL

.1 The Building Management System shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection.

.2 The BMS shall consist of the following:
.1 Digital Panel.
.2 Standalone Application Specific Controllers (ASC's).
.3 Color Graphics Workstation.

.3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASCs, and operator devices.

.4 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2.2 NETWORKING / COMMUNICATIONS

.1 Inherent in the system's design shall be the ability to expand or modify the network either via a local network, auto-dial telephone line modem connections, or a combination of the two networking schemes.

.2 Local Network
.1 Panel Support: The Digital Panel shall directly oversee a local network such that communications may be executed directly to and between ASC's.

2.2 NETWORKING / COMMUNICATIONS (Cont'd)

.2 (Cont'd)

.2 Data Access: All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application data on the network. Access to system data shall not be restricted by the hardware configuration of the facility management system.

.3 Global Data Sharing: Global Data Sharing or Global point broadcasting shall allow point data to be shared between ASCs, when it would be inefficient or impractical to locate multiple sensors.

.4 General Network Design: Network design shall include the following provisions:

.1 Data transfer rates for alarm reporting and quick point status from multiple ASCs. The minimum baud rate shall be minimum 19200 baud.

.2 Support of any combination of ASCs. A minimum of 100 ASCs shall be supported on a single local network. The bus shall be addressable for up to 255 ASCs.

.3 Detection of single or multiple failures of ASCs or the network media.

.4 Error detection, correction, and re-transmission to guarantee data integrity.

.5 Commonly available, multiple-sourced, networking components shall be used.

.6 Use of an industry standard protocol, such as Optomux, and IEEE RS-485 communications interface.

.3 Dial-Up Communications: Auto-dial/auto-answer communications shall be provided to allow Digital Panels to communicate with remote operator terminals on an occasional basis via telephone lines.

.1 Dial-Up Digital Panels: Auto-Dial Digital Panels shall automatically place calls to remote terminals to report critical alarms.

2.2 NETWORKING / COMMUNICATIONS (Cont'd)

.3 (Cont'd)

.1 (Cont'd)

.1 Digital Panels shall analyze and prioritize all alarms to minimize the initiation of calls. Non-critical alarms shall be buffered in memory and reported as a group of alarms, or until an operator manually requests a report of all alarms.

.2 The auto-dial program shall include provisions for handling busy signals, "no-answers," and incomplete data transfers. Default devices shall be called when communications cannot be established with primary devices.

.2 Dial-Up Remote Operator Terminals: Operators at dial-up remote operator terminals shall be able to perform all control functions and all data base generation and modification functions as described for local operator terminals connected via the RS-232 port. Routines shall be provided to automatically answer calls, and display information sent from remote Digital Panels. The fact that communication is taking place with remote control systems over telephone lines shall be completely transparent to an operator.

.1 An operator shall be able to access remote buildings by selecting any facility by its logical name. The PC Dial-Up program shall maintain a user-definable cross-reference of buildings and associated telephone numbers, so the user shall not be required to remember or manually dial telephone numbers.

.2 Alarm and data file transfers handled via dial-up transactions shall not interfere with local network activity, nor shall local network activity keep the remote operator's terminal from handling incoming calls.

.3 Both local and remote operators shall be able to access and perform functions with the Digital Panel simultaneously.

2.2 NETWORKING / COMMUNICATIONS (Cont'd)

.3 (Cont'd)

.2 (Cont'd)

.4 Manual and Automatic transfer of Database and Trend Information shall capable of being accomplished over the Dial-up connection to the remote Digital Panels.

.4 Modem Characteristics: Dial-up communications shall make use of 56,600 baud modems and voice grade telephone lines. Each Digital Panel shall have its own modem for remote monitoring or diagnostics purposes.

2.3 DIGITAL PANELS

.1 General: Digital Panels shall be microprocessor-based, multi-tasking, multi-user, digital control processors.

.2 Memory: Each Digital Panel shall have sufficient memory to support its own operating system and data bases including:

- Control processes
- Energy Management Applications
- Alarm Management
- Trend Data
- Maintenance Support Applications
- Operator I/O
- Dial-Up Communications
- Manual Override Monitoring

.3 Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of field controllers, sensors, and actuators.

.4 Serial Communication Ports: Digital Panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices, such as laptop computers, Personal Computers, and Video Display terminals.

.5 Override Monitoring: Digital Panels shall monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2.3 DIGITAL PANELS (Cont'd)

.6 Integrated On-line Diagnostics: Each Digital Panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. Digital Panels shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each Digital Panel.

.7 Surge and Transient Protection: Isolation shall be provided at all network termination's, as well as all field point termination's, to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

.8 Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of the Digital Panel to prevent the loss of data base or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the Digital Panel shall automatically resume full operation without manual intervention. Should Digital Panel memory be lost for any reason, the user shall have the capability of reloading the Digital Panel via the local RS-232C port, or telephone line dial-in.

.9 UPS: Provide uninterruptible power supply to hold panel operation for a minimum of 15 minutes to allow an orderly shutdown of control systems in a power interruption situation. If additional capacity is required for this situation, the BACS contractor shall include in the tender price.

2.4 SYSTEM SOFTWARE FEATURES

.1 General

.1 All necessary software to form a complete operating system, as described in this specification, shall be provided.

.2 The software programs specified in this section shall be provided as an integral part of the Digital Panel, and shall not be dependent upon any higher level computer for execution.

.2 Control Software Description:

.1 Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

.2 Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

.3 All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment described in the "Execution" portion of this specification.

.3 Programming Capability: Digital Panels shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.

.1 Process Inputs and Variables: It shall be possible to use any of the following in a configured process: - Any system-measured point data or status - Any calculated data - Any results from other processes - Boolean logic operators (and, or)

.2 Process Triggers: Configured processes may be triggered based on any combination of the following: - Time of day - Calendar Date - Other processes - Events (e.g., point alarms)

.3 Data Access: A single process shall be able to incorporate measured or calculated data from any and all other ASCs. In addition, a single process shall be able to issue commands to points in any and all other ASCs on the local network.

2.4 SYSTEM SOFTWARE FEATURES (Cont'd)

.4 Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each Digital Panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the Digital Panel's ability to report alarms be affected by either operator activity at the local I/O device, or communications with other ASCs on the network.

.1 Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

.2 Prioritizing: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of four (4) priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

.3 Report Routing: Alarm reports and messages shall be directed to an operator device.

.4 Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 60-character alarm message to more fully describe the alarm condition or direct operator response.

.5 Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until a manual request is received, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

2.4 SYSTEM SOFTWARE FEATURES (Cont'd)

.4 (Cont'd)

.6 Remote Alarm Horn: Each Digital Panel shall be capable of triggering a binary output on an ASC when a critical or network alarm is received. The alarm horn feature shall be silenced when the critical alarm is acknowledged.

.7 Trend Analysis: A data collection utility shall be provided to automatically sample, store, and display system data. Measured and calculated analog and binary data shall be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute to 24 hours, in one-minute or one-hour intervals, shall be provided. Each Digital Panel shall have a dedicated buffer for trend data, and shall be capable of storing 32 trend logs. Each trend log shall have up to 4 points trended at 168 data samples each. Data shall be stored at the Digital Panel.

.8 Runtime Totalization: Digital Panels shall automatically accumulate and store runtime hours for binary input and output points specified in the "Execution" portion of this specification.

.1 The Totalization routine shall have a sampling resolution of one minute.

.2 The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.

.5 Pulse Totalization: Digital Panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected binary pulse input-type points.

.1 Totalization shall provide calculation and storage accumulations of up to 9,999,999 units (e.g. KWH, gallons, KBTU, tons. etc.).

.2 The Totalization routine shall have a sampling resolution of one minute.

.3 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.4 SYSTEM SOFTWARE FEATURES (Cont'd)

.5 (Cont'd)

.4 The information available from the Pulse Totalization shall include, but not be limited to, the following:

Peak Demand, with date and time stamp
24-hour Demand Log Accumulated for day
Sunday through Saturday usage
Sunday through Saturday Demand
Demand annual history for past 12 periods
Annual history for past 12 periods

.6 Event Totalization: Digital Panels shall have the ability to count events, such as the number of times a pump or fan system is cycled on and off.

.1 The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

.2 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.5 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

.1 Each Digital Panel shall be able to extend its monitoring and control through the use of standalone Application Specific Controllers (ASCs).

.2 Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

.3 Each ASC shall have sufficient memory to support its own operating system and data bases including:

- Control Processes
- Energy Management Applications
- Operator I/O (Portable Service Terminal)

2.5 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS (Cont'd)

.4 The operator interface to any ASC point data or programs shall be through the Digital Panel or portable operator's terminal connected to any ASC on the network.

.5 ASCs shall directly support the temporary use of a portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following:

Display temperatures
Display status
Display setpoints
Display control parameters
Override binary output control
Override analog setpoints
Modification of gain and offset constants

.6 Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC.

2.6 OPERATOR INTERFACE

.1 Basic Interface Description:

.1 Command Entry/Menu Selection Process: Operator interface software shall minimize operator training through the use of English language prompting and English language point identification.

.2 The operator interface shall also have the option of using a mouse or similar pointing device for a "point and click" approach to facilities management. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.

2.6 OPERATOR INTERFACE (Cont'd)

.1 (Cont'd)

.3 Graphical and Text-Based Displays: At the option of the user, the Operator interface shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

.4 Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit control, display, and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

.1 Passwords shall be exactly the same for all operator devices.

.2 A minimum of four (4) levels of access shall be supported:

- Level 1 = Data Access and Display
- Level 2 = Level 1 + Operator Overrides and Commands
- Level 3 = Level 2 + Operator Management
- Level 4 = Level 3 + Database Generation and Modification.

.3 A minimum of eight (8) passwords shall be supported at each Digital Panel.

.4 Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only those items defined for the access level of the password used to log-on.

.5 User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices logged on.

.5 Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:

2.6 OPERATOR .1 (Cont'd)
Start-up or shutdown selected equipment
Adjust setpoints
Add/Modify/Delete time programming
Enable/Disable process execution
Lock/Unlock alarm reporting for each point
Enable/Disable Totalization for each point
Enable/Disable Trending
Enter temporary override schedules
Define Holiday Schedules
Change time/date
Enter/Modify analog alarm limits
Enable/Disable demand limiting
Enable/Disable duty cycle
Enable/Disable average/high/low signal select and reset.

.6 Logs and Summaries: Reports shall be generated manually, and directed to the displays. As a minimum, the system shall allow the user to easily obtain the following types of reports:

.1 A general listing of all points in the system shall include, but not be limited to, the following:

- Points currently in alarm
- Off-line points
- Points currently in override status
- Points in Weekly Schedules
- Holiday Programming.

.2 Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

.7 System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

2.6 OPERATOR INTERFACE (Cont'd)

.1 (Cont'd)

.7 (Cont'd)

.1 The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

Add/Delete/Modify Application Specific Controllers.
Add/Delete/Modify points of any type, and all associated point parameters, and tuning constants.
Add/Delete/Modify alarm reporting definition for each point.
Add/Delete/Modify energy management applications.
Add/Delete/Modify time- and calendar-based programming.
Add/Delete/Modify Totalization for every point.
Add/Delete/Modify Historical Data Trending for every point.
Add/Delete/Modify configured control processes.
Add/Delete/Modify dial-up telecommunication definition.
Add/Delete/Modify all operator passwords.
Add/Delete/Modify Alarm Messages.

.8 Programming Description: Definition of operator device characteristics, ASCs, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.

.1 Network-Wide Strategy Development: Inputs and outputs for any process shall not be restricted to a single ASC, but shall be able to include data from any and all other ASCs to allow the development of network-wide control strategies.

.9 System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hardcopy printouts of all configuration and application data.

2.6 OPERATOR INTERFACE (Cont'd)

.1 (Cont'd)

.10 Data base Save/Restore/Back-Up: Back-up copies of all ASC and Digital Panel data bases shall be stored in at least one personal computer or laptop. Users shall also have the ability to manually execute downloads of an ASC or Digital Panel data base.

.2 Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units and hot water boiler systems, shall be provided as specified in the Execution portion of this specification to optimize system performance analysis and speed alarm recognition.

.1 System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.

.2 Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention. Areas in a building or equipment within a building shall be capable of being assigned to change color to reflect the condition within the area or status of the equipment.

.3 Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

.1 The BACS contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, filters, dampers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, etc.) and electrical symbols.

.2 The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

2.6 OPERATOR .3 (Cont'd)

- Define symbols
- Position and size symbols
- Define background screens
- Define connecting lines and curves
- Locate, orient and size descriptive text
- Define and display colors for all elements
- Establish correlation between symbols or text and associated system points or other displays.
- Define an area of a graphic or a symbol and select colors for each of the point states

.3 Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility.

.4 To accomplish this, the user shall be able to build graphic displays that include point data from multiple application specific controllers.

.4 Hardware Requirements

.1 Personal Computer:

.1 Provide a desktop PC complete with Quad Core Intel Core i7 processor with a minimum 12 GB DDR3 memory, 1 TeraBit hard drive, Blu-ray/DVD combo writer, 1.5 GB graphics card, 19" ultra resolution LCD color monitor, a 56,600 Baud modem, Ethernet LAN card, Enhanced Keyboard and wireless Mouse.

.2 Printer:

.1 Provide a suitable alarm and report colour laser printer for connection to either the Digital Panel or Personal Computer.

.3 Modem:

.1 Provide a Hayes compatible 56,600 baud modem.

.4 UPS: Provide uninterruptible power supply to hold equipment operation for a minimum of 15 minutes to allow an orderly shutdown of control systems in a power interruption situation. If additional capacity is required for this situation, the BACS contractor shall include in the tender price.

2.6 OPERATOR INTERFACE (Cont'd)

.4 (Cont'd)

.5 OWS Desk

.1 Provide desk to mount P.C., printer, modem and support other activities of operator. Minimum desk surface to be 1200 mm (wide) x 750 mm (front / back) x 750 mm (high). Desk shall have shelf below top surface to support computer with monitor, keyboard and mouse on desk surface. Unit shall be mounted on casters. Location as noted on drawing.

2.7 FIELD SENSORS

.1 Temperature Sensors

.1 Temperature sensors shall be 1000 OHM platinum RTD type. Analog temperature sensors shall provide an output signal that varies continuously with the sensed temperature, within a specified range. Binary temperature sensors shall provide an output signal that is either on or off depending upon whether the sensed temperature is above or below the setpoint temperature. All sensors of a particular category shall be of the same type and manufacturer. Provide temperature sensors suitable for one or more of the following mounting methods: duct mount, pipe thermowell mount.

.2 Insertion Type - Suitable for insertion into air ducts at any angle, and shall have a minimum insertion of 150 mm.

.3 Immersion Type - Suitable for immersion into fluids in tanks or pipes with separable well and heat transfer compound. Sensor wells shall be brass and compatible with the sensor.

.4 Averaging Type with Extended Element - Suitable for duct mounting to obtain average temperature by sampling along a capillary tube element.

.5 Outside Air Sensing Type - Shall have sun shades to minimize solar effects and shall be mounted to minimize building outside air film effects.

2.7 FIELD SENSORS (Cont'd)

.1 (Cont'd)

.6 Space Type - Non-Secure Areas - occupied/unoccupied override switches. Thermostats/ sensors for terminal boxes shall have lockable access to temperature setpoint adjustment. Portable operator terminal shall be able to connect to space thermostat/sensor.

.7 Space Type - Secure Areas - Cells - locate sensors in secure &-chase areas in exhaust ducts from cells. Sensors shall be moisture resistant, general purpose RTD/thermistor sensing element suitable for duct mounting. Sensing element to be securely attached to metal enclosure with conduit connections. Enclosure to be firmly attached to duct. Sensing element to be selected to suit actual duct size.

.8 Space Type - Secure Areas - Common Spaces - locate sensors as shown on drawings. Sensors shall be moisture resistant, general purpose RTD/thermistor sensing element suitable for mounting concealed on rear side of blank wall plate. Sensing element to be firmly adhered to back of blank plate. Enclosure shall be designed and manufactured for secure installation in poured concrete walls and shall consist of 10 ga steel backplate for cast-in-place concrete construction, one-piece blank 10 ga steel front plate finished in baked white enamel and fastened with secure screws in each corner.

.2 Differential Pressure Switches

.1 All pressure sensing elements shall be corrosion resistant.

.2 Pressure sensing elements shall be diaphragm type as required by the application.

.3 Units shall have adjustable range and differential pressure settings.

.4 Pressure sensor switches shall be snap action type.

.5 Sensor assembly shall operate automatically and reset automatically when conditions return to normal.

.6 Protect complete sensor assembly against vibration at all critical movement pivots and slides.

2.7 FIELD SENSORS (Cont'd)

.2 (Cont'd)

.7 Sensors on all liquid lines shall have an isolation valve installed between each sensor and its pressure source.

.3 Control Valves

.1 Sized by temperature control manufacturer and guaranteed to meet the heating and cooling requirements; each tagged for project location. Valves shall be sized on the basis of 15% of the total system pressure drop, but not more than 34.5 kPa (5 psi) drop. Pressure drop for valves shall be submitted for review.

.2 Equal percentage type, equipped with characteristic type throttling plug, stainless steel stem, removable composition discs, and rubber diaphragms. Provided with necessary features to operate in sequence with other valves or damper operators and adjustable throttling range.

.3 Valves NPS2 and smaller: screwed bodies; NPS 2-1/2 and larger: flanged bodies; designed for 125 PSI operating pressure. Arranged to fail-safe as called for, tight closing and quiet operating.

.4 Physical sizes of valves will be such that they will fit within the physical space provided within radiation and equipment enclosures. Verify before ordering materials.

.4 Electric Operators (Valve)

.1 Provide a 24 VAC control operators which are 0-10 VDC input proportional and designed for water or steam service valve bodies. Operator shall be Synchronous motor driven with 222 N (50 lbf) force and force sensor safety stop. Enclosure shall be cast aluminum.

.5 Electric Operators (Damper)

.1 Provide 24 VAC damper actuators which are 0-10 VAC input proportional and designed to operate position dampers. Operator shall be synchronous motor driven with up to 11.3 N-m (100 in-lb)force sensor safety stops and spring return as required. Enclosure shall be cast aluminum. Unit shall be complete with end switch where indicated or required.

2.7 FIELD SENSORS (Cont'd)

.6 Static Pressure Transmitters

.1 The sensors shall be a variable capacitance type, utilizing a stainless steel diaphragm and insulated electrode for positioning of the diaphragm.

.2 The sensor shall produce a linear 4 to 20 mA or 0-5 VDC with accuracy's of 1% full scale in normal ambient temperature environments.

.3 Pressure ranges 0 to 25 Pa. through 0 to 6227 Pa.

.4 The transmitter shall be temperature compensated to account for any thermal error over the entire temperature range of 4.4°C to -37.8°C, 0-95% RH. Over-pressurization 2491 Pa. up to ten times range.

.5 The transmitter shall have zero span adjustment capability, but shall be factory calibrated.

.7 Relative Humidity Sensors

.1 Relative humidity sensors shall be an analog precision resistance type relative humidity detector. Sensor shall have an overall accuracy of +/- three (3%) percent of span over a range of 5% - 95% relative humidity.

.8 Air Flow Measurement

.1 Airflow measurement stations shall be provided in inlets of air handler equipment as shown.

.2 Sensing elements shall be manufactured of extruded aluminum with integral total and static pressure monitor chambers.

.3 Airflow sensing elements shall increase system pressure drop by less than 0.03.

2.8 ROOM PRESSURE MONITOR

.1 The room pressure monitor shall be furnished and installed to monitor the measured room pressure. The system shall include a room pressure monitor, a pressure sensor, a low voltage control transformer, and low voltage control wiring.

2.8 ROOM PRESSURE MONITOR (Cont'd)

.2 All components of the room pressure monitor shall be part of a completely designed, tested, catalogued, and factory coordinated package by a single manufacturer, for single point responsibility.

.3 The room pressure monitor shall measure and display room pressure. It shall provide access to menu driven configuration options via an integral keypad. The keypad shall be a smooth spill-proof membrane switch. Monitors requiring separate hand held programming devices to configure and calibrate the monitor are not acceptable.

.4 The system shall continuously measure, display, and output room pressure to meet the recommendations set forth in the Centers for Disease Control and Prevention's Guidelines for Preventing the Transmission of Mycobacterium Tuberculosis in Health-Care Facilities, 1994, Supplement 3: Engineering Controls. Room pressure systems that infer room pressure through CFM offset measurement are not acceptable.

.5 Measurement technology shall be "through-the-wall" type and shall be ANSI/UL 1479 listed for "Fire Tests of Through-Penetration Firestops". The unit shall have a two-hour fire rating.

.6 Room pressurization monitor shall provide a system capable of making a suitable direct measurement of the differential pressure between the controlled room and the anteroom, and shall use a bi-directional, ceramic coated, thermal anemometry using a resistance temperature sensors.

.7 Accuracy and resolution shall sense between 40 feet/minute and 400 feet/minute within 10% of reading, or 10 feet/minute, whichever is greater, shall measure between -0.20000 and +0.20000 inches H2O, shall be capable of displaying down to 0.00001 inches H2O.

.8 The sensor shall be sensitive enough to detect changes to average room pressure caused by any and all of the following as a minimum:

2.8 ROOM PRESSURE MONITOR (Cont'd)

.8 (Cont'd)
.1 changing corridor balance
.2 changing room balance
.3 changing duct static pressure
.4 open doors

.9 HVAC differential pressure transducers with resolutions of 0.0001 inches H2O or poorer are not acceptable. Uni-directional sensors are also not acceptable. Differential pressure sensor(s) must be positioned in such a way as to provide reasonable assurance of room pressure, sensing between the top of the door and the ceiling, wherever practical. In the event that space is not available to permit the sensor to be mounted above the door, it may be mounted near enough to the door, and at a position roughly equal to the height of the door, to be able to sense directional airflow under thermal cycling conditions (as defined by ANSI Z9.5). Devices using thermal anemometry must be temperature compensated to not less than 55 - 95°F, and must use proven resistance temperature detector technology for sensing velocity changes and temperature changes accordingly.

.10 The integral alarm (audible and visual) and configuration unit shall be mounted in a convenient location to alert those working in or around the room of a potentially hazardous condition (example: in corridor near door).

.11 Manufacturer shall have successful customer installations of laboratory room pressure monitor systems in operation for more than five years.

.12 The room pressure monitor system shall have a two-year parts. The warranty shall commence on the date of substantial completion.

2.8 ROOM PRESSURE MONITOR (Cont'd)

.13 In strict accordance with this specification, alternate room pressure monitor systems and equipment shall only be considered for approval provided that the equipment be equal in every respect to the operational characteristics, capabilities and intent specified herein. Approval to bid does not relieve the supplier form complying with the minimum requirements or intent of this specification to include the direct measurement of room pressure, accuracy and resolution.

.14 Pressure Sensor

.1 The pressure sensor shall consist of two velocity sensing elements mounted in-line with each other and a temperature compensating element as described in U.S. Patent #4,787,251. The velocity sensing elements shall be a ceramic coated platinum RTD for corrosion resistance and easy cleaning. Constant temperature thermal anemometry shall be used to make the air velocity measurement.Pressure transducers with resolutions of 0.0001 inches H2O or poorer are not acceptable.

.2 The pressure sensor shall be temperature compensated over a range of 55 - 95°F.

.3 The pressure sensor assembly shall consist of a molded plastic sensor, PVC tubing, intumescent rings, and a matching sensor housing. The pressure sensor is mounted on one side of the wall, the matching sensor housing on the other side of the wall, with the PVC tubing penetrating the wall.

.4 The pressure sensor assembly shall be ANSI/UL 1479 listed for "Fire Tests of Through-Penetration Firestops". The unit shall have a two-hour fire rating.

.5 The pressure sensor shall accurately measure room pressure from -0.20000 to +0.20000 inches H2O. The sensor shall be capable of measuring pressure down to 0.00015 inches H2O. The sensor shall be bi-directional to determine the proper direction of pressure. Uni-directional sensors are not acceptable.

2.8 ROOM PRESSURE MONITOR (Cont'd)

.14 (Cont'd)

.6 A 25-foot, 6-conductor, 22 AWG cable shall be provided for the wiring connection between the sensor and the pressure monitor.

.15 Room Pressure Monitor

.1 The room pressure monitor shall measure and display the room pressure. It shall provide access to menu driven configuration options via an integral keypad. the keypad shall be a smooth spill-proof membrane switch.

.2 Monitor display and configuration module shall be on integral unit. Monitors requiring separate hand held programming devices to configure and calibrate the monitor are not acceptable.

.3 The case should be an aesthetically pleasing molded case manufactured with industrial grade plastic. Case should mount to a double gang electrical box (4" wide x 4" tall x 2.5" deep). The room pressure monitor shall be capable of being mounted where convenient for the user (within 250 feet of pressure sensor).

.4 Two indicator lights shall be on the front of the monitor to indicate the following conditions:

.1 Red - ALARM conditions.

.2 Green - NORMAL or safe pressure condition.

.5 The monitor must have a sliding outer cover that fives an aesthetic appearance while protecting the display and membrane keypad. The cover shall provide the capability of concealing the display while still having the safe (green light) and alarm (red light) visible.

.6 There shall be a two-line alphanumeric digital display indicating the measured room pressure in inches of H2O. The display shall have a range of -0.20000 to +0.20000 with a resolution of 5% of reading and shall be updated every one half second.

2.8 ROOM PRESSURE MONITOR (Cont'd)

.15 (Cont'd)

.7 The alphanumeric digital display shall also indicate actual room pressure (positive, negative or no isolation), alarm status, menu options, diagnostics and error messages. In normal operation, the display shall continuously scroll information about room status, pressure, and other configurable variables as applicable; flow, air changes per hour, second sensor status and alarms.

.8 There shall be low and high alarms for negative pressure and low and high alarms for positive pressure. Each alarm shall be capable of having a unique set point.

.9 The controller shall have an audible alarm that sounds when the room is in an alarm condition. In addition, an alarm contact for low pressure alarm shall be SPST (N.O.). The contact shall close in a low alarm condition.

.10 A single test button on the face of the unit shall provide validation of Model number, software version, setpoints, alarm points, and unit self diagnostics.

.11 A linear analog pressure output shall be user selectable as either a 0-10 VDC or 4-20 mA, via the keypad. In addition, the output pressure range shall be selectable, either -0.1 to +0.1 inches H2O or -0.01 to +0.01 inches H2O.

.12 Monitor wiring shall be to a terminal strip which plugs into the back of the monitor.

.13 Appropriate materials shall enclose all electronic components.

.14 A negative pressure, no isolation input contact shall initiate the room pressure monitor to enable negative pressure alarms, or when in no isolation mode, disable all alarms. Provide a wall mounted key switch to allow this operation.

.16 Configuration

.1 All configuration shall be done through the keypad on the monitor. Units requiring hand held configuration devices are not acceptable.

.2 Display units shall be selectable as "H2O, FT/MIN, m/s, Pa or mmH2O.

2.8 ROOM PRESSURE MONITOR (Cont'd)

.16 (Cont'd)

.3 The room pressure monitor shall have user-selectable negative pressure low and high alarms.

.4 the room pressure monitor shall have user-selectable positive pressure low and high alarms.

.5 The pressure mode (positive, negative, neutral) shall be selectable via configuration keypad, dry contact or RS-485.

.6 The room pressure monitor shall have an adjustable alarm time delay, configurable from 20 - 600 seconds.

.7 The room pressure monitor shall have a configurable alarm ring back function, configurable from 5 - 30 minutes. Audible alarm will ring back if alarm condition is not corrected.

.8 The room pressure monitor shall have an adjustable display filtering capability.

.9 The room pressure monitor shall have two alarm conditions. All the alarms shall be configured to be either latched or unlatched (alarm follow).

.1 Visual indicators on the front panel shall indicate low and high alarm conditions (via the red ALARM light). The type of alarm shall also be indicated on the display.

.2 Audible alarms shall sound in all alarm conditions (unless the audible alarm has been muted or permanently turned off). The audible alarm shall be silenced at any time by pressing the MUTE key. The audible alarm shall be configurable to be permanently muted.

.3 Low alarm relay, for remote monitoring of alarm condition, shall be closed when the appropriate alarm condition has been initiated.

.10 Each menu shall be protected from unauthorized personnel through the use of a passcode.

.17 Calibration

.1 The room pressure monitor shall be factory calibrated. No initial field calibration shall be needed.

2.8 ROOM PRESSURE MONITOR (Cont'd)

.17 (Cont'd)

.2 Field calibration shall be available for future use. It shall be done electronically through the use of the integral keypad on the front panel. Calibration through the use of potentiometers or separate hand held programming devices are not acceptable.

.3 Calibration shall consist of calibrating both the sensor zero and sensor span.

.18 Sequence of Operation

.1 The room pressure sensor shall measure the air velocity between the controlled space and the referenced space. The measurement shall be made using a thermal anemometer with two velocity sensing elements mounted in-line. The measured velocity between the controlled space and reference space is then converted to the pressure differential.

.2 The pressure differential shall be transmitted to the monitor. The display shall indicate measured pressure differential.

.3 A green light on the room pressure monitor shall indicate normal or safe operating pressure.

.4 An audible and visual (red light) alarm shall indicate whenever the measured room pressure falls below the configurable low alarm set point or riss above the configurable high alarm set point. The alarm shall turn off when the measured room pressure rises 0.0001 inches H2O above the low alarm set point or falls 0.0001 inches H2O below the high alarm set point.

.5 The room pressure monitor shall function in no isolation mode (standard patient mode) by turning off all alarms.

.19 Transformer

.1 The transformer shall have a primary-side voltage of 120 VAC and a secondary-side voltage of 24 VAC. The transformer shall have a rating of 20 VA with a 0.5 amps maximum.

.2 The transformer shall be UL and CSA listed.

2.8 ROOM PRESSURE MONITOR (Cont'd)

.19 (Cont'd)
.3 A 25-foot, 2-conductor, 22 AWG cable shall be provided as the electrical interface between the transformer and the pressure monitor.

.20 Equipment Start-up, Calibration, and Training
.1 Start-up shall be performed by the manufacturer or a factory authorized representative.
.2 Start-up shall include verifying the set-up and calibration of each specified room. Ceilings and doors shall be installed and the HVAC systems (exhaust and supply fans) shall be properly air balanced before start-up shall occur.
.3 The manufacturer, or authorized factory representative, shall provide 1 hour of training for building personnel.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install the digital panel, PC, printer, and other associated hardware as per manufacturers' recommendations.

.2 Verify location of thermostats and other exposed control sensors with drawings before installation. Locate thermostats at same elevation as light switches.

.3 Install damper motors on outside of ducts. Do not locate in air stream, except for roof mounted equipment.

.4 Wire "hand/off/auto" selector switches such that automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.5 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.

.6 Install all safety limits at the operator's level.

3.1 INSTALLATION
(Cont'd)

.7 Where secure area temperature sensors are installed in masonry construction, coordinate installation with masonry trade. Temperature sensors shall be surface mounted and wall shall be patched as required.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:
.1 System requirements for Local Area Network (LAN) for Building Automation and Control System (BACS).

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
.1 CSA T568.1-05 (R2010), Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements.
.2 CSA T568.2-05 (R2010), Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair Cabling Components.
.3 CSA T530-99, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
.1 IEEE 802.3-2008, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
.1 TIA/EIA 568-2009, Commercial Building Telecommunications Cabling Standard Set (Contains: TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3 with Addendums and Erratas).
.2 TIA/EIA 569-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).

1.2 REFERENCES (Cont'd)

.4 (Cont'd)
.1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 - BACS: General Requirements.

1.4 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T568.1, CSA T568.2, TIA/EIA 568 and CSA T530, TIA/EIA 569 and TBITS 6.9.
.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:
.1 BACS-LAN.
.2 Modems.
.3 Network interface cards.
.4 Network management hardware and software.
.5 Network components necessary for complete network.

1.5 DESIGN REQUIREMENTS

.1 BACS Local Area Network (BACS-LAN).
.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
.2 BACS-LAN to: BACnet,.
.3 Each BACS-LAN to be capable of supporting at least 50 devices.
.4 Support of combination of MCUs and OWSs directly connected to BACS-LAN.

1.5 DESIGN REQUIREMENTS (Cont'd)

.1 (Cont'd)

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network medium: shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

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 Institute of Electrical and Electronics Engineers (IEEE)
.1 IEEE C2-2007, National Electrical Safety Code.

.2 Canadian Standards Association (CSA)
.1 CSA C22.1-09, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations, Includes Update No. 1 (July 2010).
.2 CSA C22.2 NO. 45-M1981 (R2003), Rigid Metal Conduit.
.3 CSA C22.2 NO. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
.4 CSA C22.2 NO. 83-M1985 (R2008), Electrical Metallic Tubing.
.5 CSA C22.3 NO. 1-10, Overhead Systems.

.3 National Fire Protection Association (NFPA)
.1 NFPA 70-2011, National Electrical Code.

1.2 SYSTEM DESCRIPTION

.1 Electrical:
.1 Division 26 to provide power wiring from power panels to BACS field panels. Circuits to be for exclusive use of BACS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.

.2 Mechanical:
.1 Pipe Taps Required For BACS equipment will be supplied and installed by Divisions 22 and 23.
.2 Wells and Control Valves Shall Be Supplied by BACS Contractor and Installed by Divisions 22 and 23
.3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs for installation to be carried by designated trade.

.3 Structural:

1.2 SYSTEM DESCRIPTION (Cont'd)

.3 (Cont'd)
.1 Special steelwork as required for installation of work.

1.3 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:
.1 Continuously direct and monitor all work.
.2 Attend site meetings.

PART 2 PRODUCTS

2.1 SPECIAL SUPPORTS

.1 Structural grade steel, primed and painted after construction and before installation.

2.2 WIRING

.1 As per requirements of Division 26.

.2 For 70 V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600 V. Colour code to CSA 22.1.

.3 For wiring under 70 volts use FT6 rated wiring where wiring is in conduit.

.4 Sizes:
.1 120 V Power supply: to match or exceed breaker, size #12 minimum.
.2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
.3 Field wiring to digital device: 20 AWG stranded twisted pair.
.4 Analog input and output: shielded #20 minimum stranded twisted pair. Wiring must be continuous without joints.
.5 More than 4 conductors: #22 minimum solid copper.

.5 Terminations:
.1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.3 CONDUIT

.1 As per requirements of Division 26.

.2 Electrical metallic tubing to CSA C22.2 NO. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 NO. 56. Rigid steel threaded conduit to CSA C22.2 NO. 45.

.3 Junction and pull boxes: welded steel.
.1 Surface mounting cast FS: screw-on flat covers.
.2 Flush mounting: covers with 25 mm minimum extension all round.

.4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.5 Outlet boxes: 100 mm minimum, square.

.6 Conduit boxes, fittings:
.1 Bushings and connectors: with nylon insulated throats.
.2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:
.1 Couplings and fittings: threaded type steel.
.2 Double locknuts and insulated bushings: use on sheet metal boxes.
.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:
.1 Connectors and couplings: steel, compression type.

2.4 SUPPORTS FOR CONDUIT, FASTENINGS EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Exposed conduits or cables:

2.4 SUPPORTS FOR CONDUIT, FASTENINGS EQUIPMENT (Cont'd)

.2 (Cont'd)
.1 50 mm diameter and smaller: one-hole steel straps.
.2 Larger than 50 mm diameter: two-hole steel straps.

.3 Suspended support systems:
.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

3.2 SUPPORTS

.1 Install special supports as required and as indicated.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:
.1 Division 26, this specification.
.2 CSA 22.1 Canadian Electrical Code.
.3 NFPA 70.
.4 IEEE C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.

.3 Do underground installation to CSA C22.3 NO. 1, except where otherwise specified.

.4 Conform to manufacturer's recommendations for storage, handling and installation.

3.3 ELECTRICAL GENERAL (Cont'd)

.5 Check factory connections and joints. Tighten where necessary to ensure continuity.

.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.9 Install conduits, and sleeves prior to pouring of concrete.

.10 Holes through exterior wall and roofs: flash and make weatherproof.

.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.4 CONDUIT SYSTEM

.1 All wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to main control panel. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.

.2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference. Conduit shall be installed tight to building structure unless authorized by the Departmental Representative.

3.4 CONDUIT SYSTEM (Cont'd)

.3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm parallel from hot pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:
.1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
.2 Provide adequate support for raceways and cables, sloped vertically to equipment.
.3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.

.10 Install polypropylene fish cord in empty conduits for future use.

.11 Where conduits become blocked, remove and replace blocked sections.

.12 Pass conduits through structural members only after receipt of Departmental Representative 's written approval.

3.4 CONDUIT SYSTEM (Cont'd)

.13 Conduits may be run in flanged portion of structural steel.

.14 Group conduits wherever possible on suspended or surface channels.

.15 Pull boxes:
.1 Install in inconspicuous but accessible locations.
.2 Support boxes independently of connecting conduits.
.3 Fill boxes with paper or foam to prevent entry of construction material.
.4 Provide correct size of openings. Reducing washers not permitted.
.5 Mark location of pull boxes on record drawings.
.6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install terminal blocks or strips indicated in cabinets.

.17 Install bonding conductor for 120 volt and above in conduit.

.18 No conduit shall be exposed in non-secure areas.

.19 Particular care is to be taken when laying out and installing conduit and devices in secure Y-chases. Conduit and devices are to be mounted so they do not protrude into service space. Orient to back side of duct or pipe to be close to wall.

3.5 WIRING

.1 Install multiple wiring in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:

3.5 WIRING (Cont'd)

.4 (Cont'd)
.1 Circuits are continuous, free from shorts, unspecified grounds.
.2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Departmental Representative with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.7 TESTS

.1 General:
.1 Perform following tests.
.2 Give 14 days written notice of intention to test.

3.7 TESTS (Cont'd)

.1 (Cont'd)

.3 Conduct in presence of Departmental Representative and authority having jurisdiction. Departmental Representative will have option to forgo attendance and allow test to proceed.

.4 Conceal work only after tests satisfactorily completed.

.5 Report results of tests to Departmental Representative in writing.

.6 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

.1 Megger all circuits, feeders, equipment for 120 - 600 V with 1000 V instrument. Resistance to ground to be more than required by Code before energizing.

.2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.

PART 1 - GENERAL

1.1 General Requirements

.1 The work of this Section will be governed by Division 1- General Requirements.

.1 Provide all calibration scales, indicators, printouts and visual displays in metric units. Use units consistent with these specifications.

1.2 Description of Systems

.1 Provide a dedicated Laboratory Air Flow Control System for each Laboratory as shown on Drawings. The systems will monitor and control airflow rates for supply air, fume hood exhaust air and laboratory exhaust. All systems are variable air volume type, each complete with electronic high speed actuator (<1 sec) for flow control with room level controller which shall be microprocessor based using peer to peer control architecture for supply and exhaust volume regulators (Venturi Air Valves), Sash positioning sensors (SPS) , fume hood monitor (FHM) zone presences sensors (ZPS) and Temperate/Humidity Sensor. All Temperature Control in the Laboratory will be by the room level microprocessor controller. Each Laboratory / Room dedicated as a zone will have a router. Provide a Network controller with BACnet compatible protocol and BTL approved.

1.3 Shop Drawings

.1 Submit Manufacture's Shop Drawings, Electrical Wiring Diagrams, Control System Drawing, and Equipment Room Schedule to the Consultant. Included in the shop drawings the following:

.1 Schematics of interconnecting control wiring of all air volume regulators, sash positioning sensors, Fume hood monitors, temperature/humidity sensor, room level control devices such as routers, programmable modules, local display units and uninterruptible power supplies. Indicated voltage and amperage requirements and selected transformer.

1.3 Shop Drawings (Cont'd)

.1 (Cont'd)

.2 Schematics of all termination points within each room level controller.

.3 Air volume regulator schedule including minimum and maximum airflow, regulator sizes, type of protective coating and sound power data.

.4 Detail including features, dimensions and installation method.

1.4 System Commissioning

.1 Provided the services of a factory certified representative to inspect system installations, to coordinate any necessary changes, start up of system, calibration of each system and train Owner's staff in proper operating and maintenance procedures. Coordinate Critical Alarms to ensure Containment and Health and Safety of laboratory.

.2 Start-up shall include calibrating fume hoods, fume hood monitors alarms and any combination sash sensing equipment, as required. Start-up shall also provide electronic verification of airflow for room supply, fume hood exhaust, general exhaust, system programming and integration to BACS.

PART 2 - PRODUCTS

2.1 General

.1 This Specification is based on Venturi Type Valves using a peer to peer system architecture and is to be understood as a volumetric offset system for room negative pressurisation and fume hood control. Systems using pressure sensing for room pressurisation and flow sensing for fume hood control are acceptable and must be pre-approved. Fume Hood Control will be critical to the evaluation.

2.2 Record Management

.1 Provide sequence of operation and control diagram for each system, complete with control piping and wiring layout of Laboratory Air Flow Control System in a format to be downloaded into the Building Management System.

2.3 Room Level Venturi Air Flow Controllers

.1 The controller for the airflow control devices shall be microprocessor based and operate using peer-to-peer control architecture. The room-level airflow control devices shall function as a standalone network. Each laboratory control system shall have the capability of performing fume hood control, pressurization control, temperature control, humidity control, and implement occupancy and emergency mode control schemes. The laboratory airflow control systems network shall have the option to integration with the BACS through an open protocol (Bacnet).

.2 The controller is to modulate supply air to maintain adjustable offset between supply and exhaust volumes maintaining constant face velocity at the fume hood. Set up the laboratory air flows in accordance with the Laboratory Control Air Flow Schedule. Air flows will be produced with the shop drawings and based on the information on the provided on the drawings.

.3 Provide output signal to fume hood monitor for incorrect airflow alarm.

.4 Provide battery backup for a minimum of 10 minutes on any device affected by power interruptions where loss of memory will occur.

.5 Use ULC listed cabinets with lockable hinged doors.

2.4 Air Flow Control Regulator

.1 Provide variable air volume regulator as indicated on drawing schedule.

2.4 Air Flow Control Regulator (Cont'd)

.2 Regulator to be pressure independent over a differential pressure range of 150 to 750 Pa (.06" to 3.0" W.C) across the valve. Integral pressure independent assembly to respond and maintain specific air flow within one second of a change in duct static pressure.

.3 Regulator air flow to be ± 5% of signal over an air flow turndown range of 16 to 1. No minimum entrance or exit duct diameters are to be required to ensure accuracy or pressure independence.

.4 Regulator to fail "Safe" with exhaust air regulators failing to maximum open position and supply air regulators failing to minimum open position upon loss of power.

.5 Regulator Construction

.1 Regulator is to have a Venturi section into which a cone shape element slides to create a smoothly varying, annular orifice. The regulator is constructed such that the venturi body's shape logarithmically necks down to the orifice area and then logarithmically re-expands to full valve inlet size to ensure a static regain with minimal pressure loss. The regulator is to have an equal percentage flow characteristic to provide an accurate linear control at the flow value.

.2 Airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be constructed of 16-gauge aluminum. The device's shaft and shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be a spring-grade stainless steel. All shaft bearing surfaces shall be made of a Teflon, polyester or PPS (polyphenylene sulfide) composite.

2.4 Air Flow Control Regulator (Cont'd)

.5 (Cont'd)

.3 The airflow control device for corrosive airstreams, such as fume hoods and biosafety cabinets, shall have a baked-on, corrosion-resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring-grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of a Teflon or PPS (polyphenylene sulfide) composite

.6 Controls: Provide factory mounted actuators and controllers.

.1 The controller is microprocessor based and operates using peer-to-peer control architecture. The room-level airflow control devices shall function as a standalone network. Modulate valve position in response to input signal from room level controls or fume hood monitor.

.2 Controller to provide feedback signal confirming commanded flow.

.7 Certification

.1 Each regulator to be factory calibrated for the air flows indicated on the Drawings. Regulators are to be electronically calibrated at the factory using NIST traceable air stations. Regulator accuracy to be verified to +5% of signal at a minimum of eight different airflows over an airflow turndown range of 16:1.

.2 Each regulator to be individually marked with device-specific factory calibration data. Include device tag number, serial number, model number, eight-point calibration information, and quality control inspection numbers. Hard copy printout to be included in Maintenance and Operating Manuals.

2.5 Fume Hood Monitors

.1 Provide a fume hood monitor for each fume hood.

.2 Fume hood monitor to have digital face velocity display, LED operation mode indicators, emergency exhaust override button and mute button for each variable volume fume hood. Display face velocity in SI units. Monitor to maintain constant face velocity across fume hood by varying exhaust airflow as sash position changes. Monitor to receive the sash position signal from the SPS, compute the total open sash area and provide an exhaust airflow control signal to the volume regulator. Response time to change in sash height to be less than one second with no more than a 5% overshoot or undershoot for a minimum change in sash open area of 5:1. System to achieve 90% of its commanded volume within one second of the sash reaching 90% of its final value.

.3 Provide LED indicators for both normal and setback, alarm free operation modes.

.4 Monitor shall have a dedicated emergency exhaust switch with an audible and visual alarm to override the sash position sensor and command maximum exhaust airflow. A latched `push to start, push to stop' switch will force the hood exhaust volume control device to its specified full flow position and command the associated supply air valve to its specified tracking position. Monitor shall have available input for remote emergency exhaust activation.

.5 Monitor shall have audible and visual alarms to indicate airflow device is unable to achieve any of the following: improper face velocity or commanded flow rate, sash opening above maximum sash position, operator-initiated emergency purge, a loss of static pressure indicating improper fan operation, or a loss of power to the airflow control device.

2.5 Fume Hood Monitors (Cont'd)

.6 When an alarm condition does occur, the monitor will have the ability to mute the audible alarm portion while maintaining the visual alarm. The alarm will automatically reset when the alarm condition returns to `normal'.

.7 Provide a differential pressure switch located across exhaust regulator sensing loss of airflow.

.8 Provide an input to allow remote activation of setback mode. The mode will allow night setback by the Building Control System or future addition of a zone presence sensor.

2.6 Sash Position Sensor

.1 Provide a sash position sensor for each variable volume fume hood.

.2 Sensor to measure the height of a vertically moving fume hood sash using a precision potentiometer, spring reel and a stainless steel, vinyl coated cable attached to the sash. Sensor to be tested to 475,000 cycles without failure.

.3 Sensor output signals are not to be influenced by heat sources such as hot plates, Bunsen burners or combustion testing in the fume hood, or by cold sources such as dry ice, either inside or outside the fume hood.

2.7 Zone Presence Sensor

.1 A presence and motion sensor shall be provided to determine an operator's presence in front of a hood by detecting the presence and/or motion of an operator, and to command the laboratory airflow control system from an in- use operating face velocity (e.g., 100 fpm) to a standby face velocity (e.g., 60 fpm) and vice versa.

2.7 Zone Presence Sensor (Cont'd)

.2 The sensor shall define a detection zone that extends approximately 20" (50 cm) from the front of the fume hood. If the sensor does not detect presence and/or motion in its detection zone within five seconds, it shall command the system to the user-adjustable standby face velocity. When the sensor detects the presence and/or motion of an operator within the detection zone, it shall command the system to the in-use face velocity within one second.

2.8 Temperature Control

.1 The laboratory control system shall regulate the space temperature through a combination of volumetric thermal override and control of reheat coils and/or auxiliary temperature control devices.

.2 Temperature control shall be implemented through the use of independent primary cooling and heating control functions, as well as an auxiliary temperature control function, which may be used for either supplemental cooling or heating. Cooling shall be provided as a function of thermal override of conditioned air with both supply and exhaust airflow devices responding simultaneously so as to maintain the desired offset. Heating shall be provided through modulating control of a properly sized reheat coil.

.3 The laboratory control system shall also provide the built-in capability for being configured for hot deck/cold deck temperature control.

.4 The auxiliary temperature control function shall offer the option of either heating or cooling mode and to operate as either a standalone temperature control loop, or staged to supplement the corresponding primary temperature control loop.

2.9 Control Wiring

.1 Provide all control wiring components, transformers, contacts etc. necessary for a complete operational system. Wiring to contactors for BACS inputs and outputs only will be by Division 25, Controls Contractor. Use an FTT-10 communication bus between the room level control regulators. Do all wiring in accordance with Division 26 of the Specifications. Provide point expansion modules for conversion of electronic signals to DDC signals as required.

.2 Provide wiring between each room router to interconnect all routers to the Gateway.

2.10 ELECTRICAL SUPPLY AND WIRING

.1 Power wiring to junction boxes in each laboratory, will be provided by Division 26. All other wiring, both line voltage and low voltage as well as transformers, relays and associated devices are the responsibility of this Section. Do all wiring in accordance with Electrical Safety Code.

PART 3 - EXECUTION

3.1 General

.1 Prepare a detailed design of the LAFC control systems and provide all control system components, wiring and commissioning under the supervision of the Mechanical Contractor.

.2 Provide airflow volume regulators for installation by Division 23.

.3 Provide all electrical wiring and devices as required to make the systems complete and operational. Line voltage power junction boxes in the centre of each Laboratory will be provided by Division 26 (Emergency Power).

3.1 General (Cont'd)

.4 Provide and ship to the fume hood manufacturer's factory the Fume Hood Monitors, Sash Position Sensors and all related accessories, installation directions, wiring junction boxes etc. required for their installation. Provide technical assist to the manufacturer with equipment mounting and installation methods, techniques and requirements.

.5 Use competent tradesmen regularly employed by the manufacturer of the control equipment to install the control system.

3.2 Nameplates

.1 Install nameplates at all duct-mounted devices including controllers, regulators, sensors etc.

.2 Label all devices mounted inside local panels using Dymo tape labels.

3.3 Room Level Devices

.1 Where applicable, mount devices above the ceiling, adjacent to the door. Contractor to confirm exact location of devices on site, with the Departmental Representative, prior to installation. Coordinate with Departmental Representative location of devices specific to occupant use.

3.4 Calibration

.1 Before handing system over to Departmental Representative, calibrate entire system. Each air volume regulator to be factory calibrated for airflows indicated on the Drawings. Regulators are to be electronically calibrated / characterized at the factory using certified NIST traceable air stations. Regulator characterization to be determined at eight unique air flows including a pressure independence test at three different static pressures between 150 Pa (0.6"W.C.) and 750 Pa (3"W.C.).

3.4 Calibration (Cont'd)

.2 Each regulator to be individually marked with valve-specific factory calibration data. As a minimum, it should include valve tag number, serial number, model number, eight-point valve characterization information, and quality control inspection numbers. Hard copy printout to be included with Record Drawings documentation.

.3 Valves to be factory set so only minor field adjustments are required by the Air Balancing Contractor. Accuracies and performance to be guaranteed as specified regardless of field conditions such as duct entry and exit configurations.

.4 The pre-calibrated regulators to restrict the function of the Air Balancing Contractor to verify air flows rather than set them. The air balancer adjustments are to ensure sufficient differential pressure across the regulator.

.5 Calibration procedures will include setting required fume hood face velocities and minimum exhaust air flow rates.

.6 At the completion of this work, provide a detailed written report documenting each system's calibration and operating points.

.7 Carry out a thorough commissioning process for each laboratory to test and confirm all operating sequences. Issue a letter confirming that the systems have been fully commissioned and are fully operational.

.8 Assist Division 25 - BACS, in demonstrating operation of Laboratory Air Flow Controls function from the BACS system.

3.5 Warranty Period

.1 Warranty shall commence upon the date of substantial completion and extend for a period of 36 months, whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the owner.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)
- .1 CSA-C22.1-2012, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.
- .2 CAN3-C235-83(R2006), 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 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).

.4 The Ontario Electrical Safety Code 2009, and all bulletins (Ontario).

.5 Hydro requirements and local applicable codes and regulations.

1.2 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235-2006.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates for control items in English.

1.3 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00.

.2 Product Data: submit WHMIS MSDS.

.3 Shop drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario within 3 weeks of Award of Contract.
.2 Submit 3 copies of 600 x 600 mm minimum size drawings and product data to inspection authorities.
.3 If changes are required, notify Departmental Representative of these changes before they are made.

.4 Quality Control: in accordance with Section 01 45 00.
.1 Provide CSA certified equipment and material.
.2 Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to site.
.3 Submit test results of installed electrical systems and instrumentation.
.4 Permits and fees: in accordance with General Conditions of contract. Pay associated fees. Departmental Representative will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost.
.5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.
.6 Submit certificate of acceptance from Electrical Inspection Department authority having jurisdiction upon completion of Work to Departmental Representative.

1.4 QUALITY ASSURANCE

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

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices as per the conditions of Provincial Act respecting manpower vocational training and qualification.

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.3 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within
weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

1.6 SYSTEM STARTUP

.1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

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

PART 2 - PRODUCTS

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products.

2.2 MATERIALS AND EQUIPMENT

.1 Provide material and equipment in accordance with Section 01 61 00.

.2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - Submittals.

.3 Factory assemble control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

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

2.4 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of inspection authorities and Departmental Representative.

.2 Decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

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

2.6 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates as follows:

.1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.

.2 Lamicoid 3 mm thick plastic engraving sheet red face, white core, mechanically attached with self tapping screws for essential (Emergency) power.

.3 Sizes as follows:

letters
letters
letters
letters
letters
letters
letters

.2 Wording on nameplates to be approved by Departmental Representative prior to manufacture.

.3 Allow for minimum of twenty-five (25) letters per nameplate.

.4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.6 Terminal cabinets and pull boxes: indicate system and voltage.

.7 Transformers: indicate capacity, primary and secondary voltages.

2.8 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code by prepainting couplings, connectors and boxes.

.3 Colours:

Service	Colour
up to 250 V	yellow
up to 600 V	brown
Telephone/lan	green
Public address/Intercom	purple
Cable television (CATV)	white
Closed Circuit television (CCTV)	orange
Fire Alarm	red
Door Control	black

2.9 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
.1 Paint outdoor electrical equipment "equipment green".
.2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1-1958.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA-C22.1-09 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

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

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.
.1 Sleeves through concrete: 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 to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32.

.2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

.4 Locate light switches on latch side of doors.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1200 mm.
.2 Wall receptacles:
.1 General: 400 mm.
.2 Above top of continuous baseboard heater: 200 mm.
.3 Above top of counters or counter splash backs: 175 mm.
.4 In mechanical rooms: 1200 mm.
.3 Panelboards: as required by Code or as indicated.
.4 Telephone and interphone outlets: 400 mm.
.5 Wall mounted telephone and interphone outlets: 1200 mm.
.6 Fire alarm stations: 1200 mm.
.7 Fire alarm bells/strobes: 2100 mm.
.8 Manual starters: 1500 mm.
.9 Isolating switches: 1500 mm.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.7 FIELD QUALITY CONTROL

.1 Load Balance: .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
.1 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
.2 Provide upon completion of work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, 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:
.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, communications.
.6 Insulation resistance testing:
.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
.3 Check resistance to ground before energizing.

.3 Carry out tests in presence of Departmental Representative.

.4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.5 Manufacturer's Field Services:

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

.6 Verification requirements include:
.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource reuse.
.5 Recycled content.
.6 Local/regional materials.
.7 Certified wood.
.8 Low-emitting materials.

3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

.3 At time of final cleaning, clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt.

.4 Remove construction materials from wiring devices, coverplates, outlets, cabinets, enclosures, tubs, etc.

3.9 FIREPROOFING

.1 Where cables or conduits pass through floors and fire rated walls proper firestopping for the specific construction shall be used. Refer to Section 07 84 00.

3.10 POWER SHUTDOWN

.1 Power shutdown shall be kept to a minimum. Schedule shutdowns well in advance with Departmental Representative stating time(s) and duration(s). Maintain all electrical services to the occupied areas of the buildings. Power shutdowns will be allowed during normal working hours and has to be approved by the institution. Shutdowns to be 4 hours maximum.

.2 Provide temporary services, equipment and wiring as necessary to maintain continuity of services throughout, during construction of this project.

.3 Ensure all services, ie. security, fire alarm, telephone, LAN, normal and essential power, etc. remain operational during construction.

3.11 REMOVALS

.1 Remove existing electrical equipment, wiring, conduit and other devices.

.2 Where existing walls and partitions are to be removed, remove existing outlets, devices and wiring located therein and make safe. Remove existing equipment, devices and outlets as necessary. Relocate or reinstall these items as indicated and as required. Co-ordinate with applicable trades.

.3 Maintain continuity of power, lighting, fire alarm and communication circuits as required.

.4 Turn over all removed material to the Departmental Representative as described.

.5 Remove all existing redundant wiring associated with all devices. Co-ordinate and arrange for telephone company to remove redundant telephone cables.

.6 Any material the Departmental Representative does not want shall be removed from the site by this contractor.

3.12 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for incorporation into operation and maintenance manuals specified in Section 01 78 00.

.2 Include in operation and maintenance data:
.1 Details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.
.2 Technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists. Advertising or sales literature not acceptable.
.3 Wiring and schematic diagrams and performance curves.
.4 Names and addresses of local suppliers for items included in maintenance manuals.
.5 Copy of reviewed shop drawings.

.3 Provide two distinct manuals, one for operational personnel and one for maintenance personnel. Provide a simplified operation instruction sheet for each system. (ie. fire alarm, door control, intercom, public address, Telephone/Lan, etc.).

.4 Update Standard Operating Procedures Manual to reflect changes to electrical systems.

3.13 TRIAL USAGE

.1 Power supply, distribution system and equipment may be put into service for trial usage provided such use will not damage equipment or void guarantees.

.2 Departmental Representative may use equipment and systems for test purposes prior to acceptance.

.3 Provide labour and equipment required for testing.

3.14 AS-BUILT RECORDS

.1 As work progresses, maintain accurate records to show deviations from contract drawings. The Departmental Representative will provide a set of clean white prints for this purpose.

.2 As Built Drawings must be updated and submitted at the end of each phase.

3.15 MAINTENANCE SCHEDULE

.1 Provide information for a computerized maintenance schedule indicating regular maintenance checks, procedures and results for insertion into a computerized maintenance program at the institution by institution personnel.

Manufacturer:
Voltage:
Phase:
Model:
Serial No.:
Etc.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION .1 Co-ordination Study:

.1 A Short Circuit Study will be conducted to determine the maximum duty that the system protective devices, cables, transformers, and interconnections will be subjected to in the event of three phase faults.

.2 The portion of the system included in the study will be that represented by the composite one-line diagram pertaining only to the new electrical panels and existing busduct mounted switches that are to feed said panels and new associated components.

.3 Input data shall include the utility short circuit contribution, resistance and reactance components of the branch impedance's, the X/R ratios, motor and generator contributions, base quantities selected, and other source impedance's.

.4 Calculate the maximum available fault current at each significant location in the noted portion of the system. The short circuit tabulations shall include symmetrical fault currents and X/R ratios, for both momentary and interrupting conditions. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be included with its respective S/R ratio.

.5 All short circuit calculations will be made in accordance with the latest standards adopted by the American National Standards Institute (ANSI) and the Canadian Electrical Code (CEC).

.6 Each interrupting protective device will be analyzed to determine if its interrupting and momentary ratings can withstand interrupting and momentary duties. If the study reveals problems, the study will recommend changes to improve system performance.

.7 Using the SKM Systems Analysis, Power Tools For Windows Computer Program, plot time-current co-ordination curves showing phase and ground-fault protective device time-current characteristics. The curves will illustrate the co-ordination among the devices shown on the system one-line diagram.

.8 The co-ordination curves will include, as a minimum, the following information:

.1 Appropriate CEC and ANSI protection criteria for equipment.

.2 Magnetizing inrush points of transformers.

.3 A simplified one-line diagram identifying the devices plotted.

.4 Short-circuit current levels used for coordination.

.5 Motor starting characteristics, where applicable.

.2 Arc Flash:

.1 Complete the Arc Flash Hazard Analysis in accordance with the procedures of IEEE St 1584.

.2 The analysis is performed in conjunction with a short circuit analysis of the existing system and will utilize the existing settings and ratings of the protective devices. Fault currents and protective device clearing times are required to perform the Arc Flash Hazard Analysis. Results of the Arc Flash Hazard Analysis are used to define the flash protection boundary and the incident energy at all locations described in the scope of work below.

.3 Arc flash study to CSA Z462-08 Workplace Electrical Safety.

1.2 QUALIFICATIONS

.1 Contractor shall have the coordination study prepared by qualified engineers of an independent consultant. Consultant shall be a Registered Professional Electrical Engineer (licensed in the province where the project is completed) who has at least ten (10) years of experience and specializes in performing power system studies.

.2 Perform short circuit and coordination study and Arc Flash using the industry recognized program for Windows computer software package.

1.3 SUBMITTALS

.1 Submit power system studies within 30 days after the electrical equipment submittals have been received for review by the Departmental Representative.

.2 Submit three (3) copies of the power systems study.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 RESULTS SHORT CIRCUIT AND CO-ORDINATION

.1 At the conclusion of the Study, submit the following:

.1 Fault current calculation summary listing momentary and interrupting duties with their respective X/R ratios;

.2 Tabulated summaries listing circuit breaker, fuse and other protective device interrupting and momentary duties in percent of their respective ratings;

.3 Complete fault current magnitudes, including individual branch current contributions, for each bus in the electrical distribution system;

.4 Complete tabulation of circuit breaker, fuse and other protective device momentary and interrupting ratings versus calculated short circuit duties for every protective device in the scope of the Short Circuit Analysis;

.5 Recommendations for replacement or retrofit of over-dutied protective devices; and

.6 Definitions of terms and guidelines for interpretation of computer printout;

.7 Time-current co-ordination curves containing the information described above;

.8 Tabulations of recommended protective device settings identified by location, equipment number, function number and adjustable range; and

.9 General recommendations for replacement devices when the study determines those existing devices do not provide proper protection or co-ordination.

3.2 RESULTS ARC FLASH

.1 Incident energy calculations will be performed and the printed label data will be based on the worst case at the label location. In addition, for any label location that is fed by an emergency generator, the worst case (Normal or Emergency) will be used for the label printing.

.2 At the conclusion of the Arc Flash Hazard Analysis, submit the following for each circuit condition and arc location analyzed:
.1 Arcing fault magnitude;
.2 Device clearing time;
.3 Duration of arc;
.4 Arc flash boundary;
.5 Working distance;
.6 Incident energy;
.7 Suggested clothing based on Table 130.7(11) of NFPA 70E-2009; and
.8 One Arc Flash Label for each location identified.

.3 Where the hazard risk category is high, offer general recommendations to reduce the incident energy.

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.18.4-04(R2009), Hardware for the Support of Conduit, Tubing and Cable.
- .2 CAN/CSA-C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
- .3 CSA C22.2 No.65-03, Wire Connectors.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
- .1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA).

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

.2 Divert unused wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 All fixtures and Branch Circuit wiring joints, in junction and outlet boxes shall be made with CSA Certified Pressure Type connectors rated at 600 volts maximum (1,000 volts when enclosed in fixture or sign). Connector body shall consist of a cone-shaped coil spring insert, insulated with a colour-coded, flame-retardant shell which shall be knurled for easy grip and capable for use with an Electrician's Pliers.

PART 3 - EXECUTION

3.1 INSTALLATION .1 Remove insulation carefully from ends of conductors and:

.1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65-03.

.2 Install fixture type connectors and tighten. Replace insulating cap.

.3 Install bushing stud connectors in accordance with NEMA.

END OF SECTION

PART 1 - GENERAL

1.1 PRODUCT DATA

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

1.2 REFERENCES

.1 CSA C22.2 No .0.3-09, Test Methods for Electrical Wires and Cables.

.2 CAN/CSA-C22.2 No. 131-07, Type TECK 90 Cable.

1.3 PRODUCT DATA

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

1.4 DELIVERY, STORAGE AND HANDLING

.1 Packaging Waste Management: remove for reuse and return of pallets, crates, paddling and packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 or 1000 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE or RWU90 XLPE, Non Jacketted.

2.2 TECK 90 CABLE

.1 Cable: to CAN/CSA-C22.2 No. 131-07.

.2 Conductors:
.1 Grounding conductor: copper.
.2 Circuit conductors: copper, size as indicated.

.3 Insulation:
.1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 or 1000 V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: flat interlocking aluminum.

.6 Overall covering: thermoplastic material.

.7 To CSA C22.2 No. 0.3 Vertical Tray Fire Test.

.8 Fastenings:
.1 'P' clamps on 'U' channels.
.2 Channel type supports for two or more cables at 900 mm centers.
.3 Threaded rods: 6 mm dia. to support suspended channels.

.9 Connectors:
.1 Watertight approved for TECK cable.

2.3 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90.

.3 Armour: interlocking type fabricated from aluminum strip.

.4 Connectors: anti short connectors.

2.4 CONTROL CABLES

.1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
.1 Insulation: thermoplastic.
.2 Sheath : thermoplastic jacket.

.2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:
.1 Insulation: TWH.
.2 Shielding: tape coated with paramagnetic material wire over each conductor.
.3 Overall covering: polyethylene jackets.

.3 Type: 600 V stranded annealed copper conductors, sizes as indicated:
.1 Insulation: RW90 (x-link).

.2 Shielding: non-magnetic tape over each conductor.
.3 Overall covering: thermosetting jackets.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Perform tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

.1 Terminate cables in accordance with Section 26 05 20.

.2 Cable Colour Coding: to Section 26 05 00.

.3 Conductor length for parallel feeders to be identical.

.4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

.6 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.

.7 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:
.1 In conduit systems in accordance with Section 26 05 34.

3.4 INSTALLATION OF TECK90 CABLE (0-1000 V)

.1 Group cables wherever possible on channels.

.2 Install cable exposed, securely supported by straps.

3.5 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible on channels.

.2 Install AC90 armoured cable from junction boxes located in main EMT runs in all accessible T-Bar ceilings, mechanical and electrical rooms with no ceilings to lights. Maximum length 1.5 meters.

3.6 INSTALLATION OF CONTROL CABLES

.1 Install control cables in conduit and cable troughs.

.2 Ground control cable shield.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 Grounding equipment based on CSA C22.2 No. 41-07.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Grounding conductors: bare stranded copper, soft annealed, size as indicated.

.2 Insulated grounding conductors: green, type RW90.

.3 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, accessories. Where PVC, flexible conduit and EMT is used, run ground wire in conduit.

.2 Install connectors in accordance with manufacturer's instructions.

.3 Protect exposed grounding conductors from mechanical injury.

.4 Use mechanical connectors for grounding connections to equipment provided with lugs.

.5 Soldered joints not permitted.

.6 Install bonding wire for flexible conduit, connected at both one ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.7 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.8 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

3.2 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Duct systems, frames of motors, motor control centres, starters, control panels, building steel work, distribution panels.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

PART 1 - GENERAL

1.1 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

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

1.2 RESTRICTIONS

.1 Explosive driven fasteners shall not be used except by specific approval.

PART 2 - PRODUCTS

2.1 SUPPORT CHANNELS

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

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Secure equipment to solid masonry, tile and plaster surfaces with epoxy anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with expandable inserts.

.4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.6 Fasten exposed conduit or cables to building construction or support system using straps.
.1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
.2 Two-hole steel straps for conduits and cables larger than 50 mm.
.3 Beam clamps to secure conduit to exposed steel work.

.7 Suspended support systems.
.1 Support individual cable or conduit runs with 6 mm dia. threaded rods and spring clips.
.2 Support 2 or more cables or conduits on channels supported by 6 mm dia. threaded rod hangers where direct fastening to building construction is impractical.

.8 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.

.9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.11 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.

.13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

.14 Provide channels for mounting of conduit, wiring and devices on walls of tunnels, mechanical rooms and attics.

.15 Provide spacers to prevent direct contact between 'U' channels and concrete.

.16 File rough edges of cut 'U' channels and paint with galvanizing paint.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA C22.1-09, Canadian Electrical Code, Part 1, 21st Edition.

1.2 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:
.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Provide shop drawings: in accordance with Section 01 33 00.
.1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 JUNCTION AND PULL BOXES

.1 Construction: welded steel enclosure.

.2 Covers Flush Mounted: 25 mm minimum extension all around.

.3 Covers Surface Mounted: screw-on flat covers.

.4 Cast junction and pull boxes in tunnels and attics.

PART 3 - EXECUTION

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Only main junction and pull boxes are indicated. Install additional pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.2 IDENTIFICATION

.1 Equipment Identification: to Section 26 05 00.

.2 Identification Labels: size 2 indicating system name voltage and phase.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA C22.1-2012, Canadian Electrical Code, Part 1, 25th Edition.

1.2 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00.

.2 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 0.

PART 2 - PRODUCTS

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1-09.

.2 102 mm square or larger outlet boxes as required.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 GALVANIZED STEEL OUTLET BOXES

.1 One-piece electro-galvanized construction.

.2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

.4 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.5 Extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3 MASONRY BOXES

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

2.4 CONCRETE BOXES

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

2.5 CONDUIT BOXES

.1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of devices in mechanical rooms and attics.

2.6 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.

.5 Vacuum clean interior of outlet boxes before installation of wiring devices.

.6 Identify systems for outlet boxes as required.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CAN/CSA-C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
.2 CAN/CSA-C22.2 NO. 18.1-04 (R2009), Metallic Outlet Boxes.
.3 CAN/CSA-C22.2 NO. 18.2-06, Nonmetallic Outlet Boxes.
.4 CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.
.5 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
.6 CSA C22.2 No. 83-M1985(R2008), Electrical Metallic Tubing.
.7 CSA C22.2 No. 211.2-06, Rigid PVC (Unplasticized) Conduit.

1.2 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
.1 Submit cable manufacturing data.

.3 Quality assurance submittals:
.1 Test reports: submit certified test reports.
.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
.3 Instructions: submit manufacturer's installation instructions.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

PART 2 - PRODUCTS

2.1 CONDUITS

.1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with expanded ends.

.2 Flexible metal conduit: to CSA C22.2 No. 56, aluminum liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits NPS 2 50 mm and smaller.
.1 Two hole steel straps for conduits larger than NPS 2 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1.2 m on centre.

.4 Threaded rods, 6 mm diameter, to support suspended channels.

2.3 CONDUIT FITTINGS

.1 Fittings: to CAN/CSA C22.2 No. 18-98(R2003), manufactured for use with conduit specified. Coating: same as conduit.

.2 Ensure factory "ells" where 90 degrees bends for NPS 1 27 mm and larger conduits.

.3 Watertight connectors and couplings for EMT.
.1 Set-screws are not acceptable.

2.4 FISH CORD

.1 Polypropylene.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas such as attics.

.3 Use electrical metallic tubing (EMT) in electrical rooms, mechanical rooms, and inaccessible ceilings.

.4 Use flexible metal conduit for connection to motors in dry areas, and connection to surface or recessed fluorescent fixtures.

.5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.6 Minimum conduit size for lighting and power circuits: NPS 3/4 21 mm.

.7 Bend conduit cold:
.1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.8 Mechanically bend steel conduit over 21 mm diameter.

.9 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.10 Install fish cord in empty conduits.

.11 Run 3-NPS 1 27 mm spare conduits up to accessible ceiling space from each flush panel.

.1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.

.12 Remove and replace blocked conduit sections.
.1 Do not use liquids to clean out conduits.

.13 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 – GENERAL

1.1 GENERAL

.1 The purpose of this section is to specify Division 26 responsibilities in the commissioning process.

.2 The systems to be commissioned are listed in Section 01 91 00.1.9.

.3 Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 01 91 00. Division 26 shall be familiar with all parts of Section 01 91 00 and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.2 RELATED SECTIONS

.1 Section 20 08 01 – Commissioning Fire Alarm Systems.

1.3RESPONSIBILITIES

.1 Electrical Contractors. The commissioning responsibilities applicable to the Electrical Contractor are as follows (all references apply to commissioned equipment only):

.1 Documentation of all procedures performed shall be provided and forwarded to the engineer. Written documentation must contain recorded test values of all electrical tests performed per the individual product specification.

.2 The start-up service company shall be present during energization of the electrical equipment. Jobsite and equipment access must be provided by the Electrical Contractor.

.3 The contractor shall supply a power source, specified by the start-up service company, for on-site test equipment.

.4 The contractor is to attend all factory witness testing required within the respective specification sections. The contractor is responsible to cover all their costs and include them in their bid.

.5 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.6 Include the cost of commissioning in the contract price, if not yet let.

.7 In each purchase order or subcontract written, include requirements for submittal data, O&M data and training.

.8 Attend a commissioning scoping meeting and other necessary meetings scheduled by the CA to facilitate the Cx process.

.9 Contractors shall provide normal cut sheets and shop drawing submittals to the CA of commissioned equipment. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of pre-functional and functional testing procedures.

.1 Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests,full factory testing reports (if any), and full warranty information including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.

.2 The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.

.10 Provide a copy of the O&M manuals submittals of commissioned equipment, through normal channels, to the CA for review.

.11 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

.12 Provide assistance to the CA in preparation of the specific functional performance test procedures specified in Section 26. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

.13 Develop a full start-up and checkout plan using manufacturer's start-up procedures and the pre-functional test sheets from the CA. Submit manufacturer's detailed start-up procedures and the full start-up plan and procedures and other requested equipment documentation to CA for review.

.14 During the startup and checkout process, execute and document the electrical-related portions of the pre-functional test sheets provided by the CA for all commissioned equipment.

.15 Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.

.16 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

.17 Perform functional performance testing under the direction of the CA for specified equipment in Table 1 of this section (Section 26 08 00). Assist the CA in interpreting the monitoring data, as necessary.

.18 Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, PM/GC and A/E and retest the equipment.

.19 Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

.20 During construction, maintain as-built red-line drawings for all drawings. Update after completion of commissioning (excluding deferred testing). Prepare red-line as-built drawings for all drawings.

.21 Provide training of the Owner's operating personnel as specified.

.22 Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

.23 Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.

.24 Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2 – PRODUCTS

2.2 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 SUBMITTALS .1 Section 26 Contractors shall provide submittal documentation relative to commissioning to the CA as requested by the CA. Refer to Section 01 91 00 Part 3.3 for additional Section 26 requirements.

3.2 START-UP OF EQUIPMENT

.1 The Electrical Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in Section 01 91 00, Part 3.4. Section 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.

.2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems, or sub-systems at the discretion of the CA and PM. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all Pre Functional test sheets as soon as possible.

.3 All equipment shall be started by the Manufacturer’s representative.

3.3 PRE-FUNCTIONAL TEST SHEETS

.1 Pre-functional test sheets contain items for Section 26 Contractors to perform. On each checklist, a column is provided that is to be completed by the contractor assigning responsibility for that line item to a trade. Those executing the test sheets are only responsible to perform items that apply to the specific application at hand. These test sheets do not take the place of the manufacturer’s recommended checkout and start-up procedures or report. Some checklist procedures may be redundant in relation to checkout procedures that will be documented on typical factory field checkout sheets. Double documenting may be required in those cases.

.2 Refer to Section 01 91 00 for additional requirements regarding pre-functional test sheets, startup and initial checkout. Items that do not apply should be noted along with the reasons on the form. If this form is not used for documenting, one of similar rigor and clarity shall be used pending approval from the CA. Contractor's assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off. "Contr." column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = Architect/Engineer, All = all Contractors, CA = Commissioning Agent, CC = Controls Contractor, EC = Electrical Contractor, PM/GC = General Contractor, MC = Mechanical Contractor, SC = Sheet Metal Contractor, TAB = Test and Balance Contractor.

3.4 OPERATIONS AND MAINTENANCE MANUALS

.1 Section 26 Contractors shall compile and prepare documentation for all equipment and systems covered in Section 26 and deliver to the GC for inclusion in the O&M manuals.

.2 The CA shall receive a copy of the O&M manuals for review.

3.5 TRAINING OF OWNER PERSONNEL

.1 The GC shall be responsible for training coordination and scheduling and ultimately to ensure the training is completed. Refer to Section 01 91 00 for additional details.

.2 The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment Refer to Section 01 91 00 for additional details.

.3 Electrical Contractor: The Electrical Contractor shall have the following training responsibilities:

.1 Provide the CA with a training plan two weeks before the planned training according to the outline described in Section 01 91 00, Part 3.8.

.2 Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.

.3 Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

.4 During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

.5 The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.

.6 The training sessions shall follow the outline in the Table of Contents of the Operation and Maintenance (O&M) manual and illustrate whenever possible the use of the O&M manuals for reference.

.7 Training shall include:

.1 Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.

.2 Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in

all modes possible, shut-down, seasonal changeover and any emergency procedures.

.3 Discuss relevant health and safety issues and concerns.

.4 Discuss warranties and guarantees.

.5 Cover common troubleshooting problems and solutions.

.6 Explain information included in the O&M manuals and the location of all plans and manuals in the facility.

.7 Discuss any peculiarities of equipment installation or operation.

.8 Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.

.9 Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and maintenance of all pieces of equipment.

.10 The Electrical Contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.

.11 Training shall occur after functional testing is complete, unless accepted otherwise by the Project Manager.

3.6 DEFERRED TESTING

.1 Refer to Section 01 91 00, Part 3.9 for requirements of deferred testing.

3.7 WRITTEN WORK PRODUCTS

.1 Written work products of Section 26 Contractors will consist of the startup and initial checkout plan as described in Section 01 91 00, as well as completed startup, initial checkout and pre-functional test sheets.

END OF SECTION

PART 1 - GENERAL

1.1 WORK INCLUDED

.1 Provide all wall mounted equipment in sprinklered areas with accessories to prevent the entry of water into the enclosures in the event that the sprinkler system is activated.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Gaskets on on lighting, receptacle and distribution panelboards.

.2 Gaskets on doors and drip shields on fire alarm and communication systems panels and enclosures.

.3 Louvres facing outward and downward where openings are required for heat dissipation. Expanded metal screening is not acceptable.

.4 CSA certified sealing rings for rigid steel galvanized conduit and CSA certified raintight connectors for steel galvanized electrical metallic tubing (EMT).

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install sealing rings and raintight connectors on all conduit terminations entering the top or side of all panel enclosures and for all conduit terminations for pull boxes, junction boxes, splitter troughs, wireways, auxiliary gutters, cable troughs and disconnect switches installed below the level of the sprinkler heads.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation for standard and custom breaker type panelboards.

1.2 RELATED SECTIONS

.1 Section 06 10 12 - Rough Carpentry: Plywood Backboard.

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

.3 Section 26 28 16.02 - Moulded Case Circuit Breakers.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA C22.2 No.29-M1989(R2004), Panelboards and enclosed Panelboards.

1.4 SHOP DRAWINGS

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

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 PANELBOARDS

.1 Panelboards: to CSA C22.2 No.29-M1989(R2004) and product of one manufacturer.
.1 Install circuit breakers in panelboards before shipment.
.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 250 V panelboards: bus and breakers rated for 10000 A (symmetrical) interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two keys for each panelboard and key panelboards alike.

.6 Copper bus with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers.

.8 Trim with concealed front bolts and hinges.

.9 Trim tub and door finish: baked grey enamel.

2.2 BREAKERS

.1 Breakers: to Section 26 28 16.02.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 To avoid counterfeit breakers, a Letter of Authenticity is required from the Manufacturer.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit and breaker size.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards in accordance with Section 06 10 12. Where practical, group panelboards on common backboard.

.3 Mount panelboards to height specified in Section 26 05 00 or as indicated.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

.6 Co-ordinate the thickness of partition walls in which panelboards are to be located prior to rough-in. Failure to do this work shall require this Contractor to assume any costs for modifying walls, revising panels or electrical components.

.7 Thoroughly vacuum all panelboards to remove construction debris and dust, prior to installation of panel covers.

.8 Multi-section double wide panelboard tubs shall be spaced 40 mm apart and secured together using manufacturer's spacers and mounting hardware. A minimum of two close nipples complete with locknuts shall be installed between the tubs.

.9 Install 3 - 27 mm spare conduits up to ceiling space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes located in the accessible ceiling space above.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA-C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
.2 CAN/CSA-C22.2 No.42.1-00(R2004), Cover Plates for Flush-Mounted Wiring Devices (Bi-National standard, with UL 514D).
.3 CSA-C22.2 No.55-M1986(R2008), Special Use Switches.
.4 CSA-C22.2 No.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 SWITCHES

.1 20 A, 120 V, single pole, three-way, four-way switches to: CSA-C22.2 No.55-M1986(R2008) and ANSI/CSA-C22.2 No.111-10.

.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 brown 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.

2.2 RECEPTACLES

.1 Duplex receptacles, CSA type 5-20 R, 125 V, 20 A, T-slot, U ground, to: CSA-C22.2 No.42 with following features:
.1 Brown urea moulded housing.
.2 Suitable for No. 10 AWG for back and side wiring.
.3 Break-off links for use as split receptacles.
.4 Eight back wired entrances, four side wiring screws.
.5 Triple wipe contacts and rivetted grounding contacts.

.2 Other receptacles with ampacity and voltage as indicated.

.3 Receptacles of one manufacturer throughout project.

2.3 COVER PLATES

.1 Cover plates for wiring devices to: CAN/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 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

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.
.4 Locate light switches on latch side of door.

.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 as indicated.
.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
.4 Install receptacles with U ground facing downwards.

.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.

.4 Device Identification: 1 Identify all receptacles with self adhesive marker describing circuit number (ie. "115-1"). Marker shall be fastened around mounting ears of receptacle.
.1 Identify all receptacle coverplates with clear self-adhesive mylar tape with black lettering.

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 Product Data:
.1 Provide fuse performance data characteristics for each fuse type and size above 100 A. Performance data to include: average melting time-current characteristics.

.3 Shop Drawings:
.1 Provide shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
.2 Submit drawings stamped and signed by professional engineer registered or licensed in Province s Territory ies of, Canada.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Ship fuses in original containers.

.2 Store fuses in original containers in storage cabinet or moisture free location.

.3 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

1.3 EXTRA MATERIALS

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

.2 Three spare fuses of each type and size installed above 100 A.

PART 2 - PRODUCTS

2.1 FUSES - GENERAL

.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

.2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

.1 Class L fuses.
.1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
.2 Type L2, fast acting.

.2 Class J fuses.
.1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
.2 Type J2, fast acting.

.3 Class R -R fuses.
.1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
.2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

.4 Class C fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.

.2 Ensure correct fuses fitted to physically matched mounting devices.
.1 Install rejection clips for Class R fuses.

.3 Ensure correct fuses fitted to assigned electrical circuit.

.4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

.5 Provide spare fuses to Departmental Representative.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers, and ground-fault circuit-interrupters.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA-C22.2 No. 5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with ANSI/UL 489, and NMX-J-266-ANCE).

1.3 SUBMITTALS

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

.2 Include time-current characteristic curves for breakers with ampacity of 600 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

.2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan.

PART 2 - PRODUCTS

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers, and Ground-fault circuit-interrupters: to CSA C22.2 No. 5-09.

.2 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.5 Circuit breakers with interchangeable trips as indicated.

.6 Circuit breakers to have minimum 10,000 A symmetrical rms interrupting capacity rating.

.7 To avoid counterfeit breakers, a Letter of Authenticity is required from the Manufacturer.

2.2 THERMAL MAGNETIC BREAKERS DESIGN A

.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.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Equipment and installation for ground fault circuit interrupters (GFCI).

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2 No.144-M91(R2061), Ground Fault Circuit Interrupters.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00.

.2 Submit product data and shop drawings.

.3 Submit test report for field testing of ground fault equipment to Departmental Representative and a certificate that system as installed meets criteria specified herein.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

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

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA-C22.2 No.144-M91(R2006).

.2 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

.1 Single pole ground fault circuit interrupter for 20 A (T-Slot), 120 V, 1 phase circuit c/w test and reset facilities.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Do not ground neutral on load side of ground fault relay.

.2 Pass phase conductors including neutral through zero sequence transformers.

.3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Arrange for field testing of ground fault equipment by Contractor before commissioning service.

.3 Demonstrate simulated ground fault tests.

END OF SECTION

PART 1 - GENERAL

1.1 PRODUCT DATA

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

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

.1 Non-fusible, horsepower rated disconnect switch in CSA Enclosure 3R for exterior or 12 for interior, size as indicated.

.2 Provision for padlocking in on-off switch position by three locks.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Quick-make, quick-break action.

.5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00.

.2 Indicate name of load controlled on size 4 nameplate.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

.2 Mount securely at 1800 mm above finished floor to top of switch. Provide a minimum of 1000 mm clear floor space in front of the switch.

3.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section Identification 26 05 00.

.2 Nameplate for each disconnect switch Size 5 engraved in accordance with Section 26 05 00. Indicate disconnect load, amperage, voltage, and phase (e.g., rooftop unit, 60 amp, 120/208 V, 3 phase).

.3 Identify circuit number and power supply equipment on disconnect switch (e.g. "B-36").

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation for contactors for system voltages up to 600 V.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA C22.2 No.14-10, Industrial Control Equipment.

1.3 PRODUCT DATA

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

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 CONTACTORS

.1 Contactors: to CSA C22.2 No.14-10.

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.

.3 Breaker combination contactor as indicated.

.4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.5 Mount in CSA Enclosure 12 unless otherwise indicated.

.6 Include following options in cover:
.1 Red indicating lamp.
.2 Hand-Off-Auto selector switch.

.7 Control transformer: in accordance with Section 26 29 03, in contactor enclosure.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00.

.2 Size 4 nameplate indicating name of load controlled voltage and circuit identification.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install contactors and connect auxiliary control devices.

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 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA C22.2 No.14-10, Industrial Control Equipment.

.2 National Electrical Manufacturers Association (NEMA)
.1 NEMA ICS 1-2002(R2008), Industrial Control and Systems: General Requirements.

1.3 SHOP DRAWINGS

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

.2 Include schematic, wiring, interconnection diagrams.

1.4 QUALITY ASSURANCE

.1 Submit to Departmental Representative one copy of test results.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 AC CONTROL RELAYS

.1 Control Relays: to CSA C22.2 No.14-10 and NEMA ICS 1-200(R2008).

.2 Convertible contact type: contacts field convertible from NO to NC, electrically held. Coil rating: 120 V, 50 VA. Contact rating: 120 V, 15 A.

.3 Sealed contact type: electrically held with 3 poles and front mounted contact block to provide 3 additional poles. Coil rating: 120 V, 50 VA. Contact rating: 120 V, 15 A.

.4 Universal pole type: electrically held with 3 poles, convertible from NO to NC by changing wiring connections. Coil rating: 120 V, 50 VA. Contact rating: 120 V, 15 A.

.5 Fixed contact plug-in type: heavy duty with 3 poles. Coil rating: 120 V, 50 VA. Contact rating: 120 V, 15 A.

2.2 RELAY ACCESSORIES

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

2.3 INSTANTANEOUS TRIP CURRENT RELAYS

.1 Enclosure: open type.

.2 Contacts: NO, NC automatic reset with adjustable tripping point.

.3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.

.4 Contact rating: NEMA ICS 1.

2.4 OPERATOR CONTROL STATIONS

.1 Enclosure: CSA Type 12, surface or flush mounting.

2.5 SELECTOR SWITCHES

.1 Maintained, 3 position labelled as indicated heavy duty oil tight, operators wing lever, contact arrangement as indicated, rated 120 V, 20 A, AC.

2.6 INDICATING LIGHTS

.1 Heavy duty Oil tight, full voltage, lens colour: red as indicated, supply voltage: 120 V, lamp voltage: 120 V, labels as indicated.

2.7 CONTROL AND RELAY PANELS

.1 CSA Type 12 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.8 CONTROL CIRCUIT TRANSFORMERS

.1 Single phase, dry type.

.2 Primary: 208 V, 60 Hz AC.

.3 Secondary: 120 V, AC.

.4 Rating: 50 VA.

.5 Secondary fuse: 1 A.

.6 Close voltage regulation as required by magnet coils and solenoid valves.

PART 3 - EXECUTION

3.1 INSTALLATION

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

.2 Co-ordinate with Mechanical Controls (B.A.S.) Contractor for field wiring of B.A.S. Overide contact for lighting control contactors.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.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 REFERENCES

.1 American National Standards Institute (ANSI)
.1 ANSI C82.1, American National Standard for Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts.
.2 ANSI/NEMA C82.4-2002, American National Standard for Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).

.2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
.1 ANSI/SCTE81 2007, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

.3 ASTM International Inc.
.1 ASTM F1137-11, Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.4 Canadian Standards Association (CSA International).

.5 ICES-005-07, Radio Frequency Lighting Devices.

.6 Underwriters' Laboratories of Canada (ULC).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:
.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative.
.3 Photometric data to include:
.1 Total input watts.
.2 Candela.
.3 Distribution zonal lumen summary.
.4 Luminaire efficiency.
.5 Coefficient of utilization.

.6 Lamp type.

.3 Quality assurance submittals: provide following in accordance with Section 01 45 00.
.1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00.

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

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates paddling and packaging materials in accordance with Section 01 74 20.

.4 Divert unused metal materials from landfill to metal recycling facility.

.5 Disposal and recycling of fluorescent lamps as per local regulations.

.6 Disposal of old PCB filled ballasts.

1.4 SPARE LAMPS AND BALLASTS

.1 Provide spare lamps as follows:
.1 5% of each lamp type.

.2 Provide spare ballasts as follows:
.1 Two (2) spare ballasts for each type and wattage of fluorescent ballast.

1.5 GUARANTEE

.1 Replace:
.1 Fluorescent lamps burning out within 6 months of takeover.
.2 Ballasts that fail or exceed their original noise level rating within 12 months of Substantial Performance of Work.

PART 2 - PRODUCTS

2.1 LAMPS

.1 Fluorescent lamps shall be T8 diameter bulb, medium bipin, rapid start type, rated at 20,000 hour life, 3000 initial lumens (32W), 3500°K correlated colour temperature, 85 colour rendering index (CRI).

2.2 BALLASTS

.1 Fluorescent Ballasts (T8):
.1 Voltage rating shall be as indicated in luminaire schedule with a range of plus or minus 10% of nominal.
.2 Fluorescent ballasts shall be high frequency, electronic rapid start type, operating lamps at a frequency of 21 kHz or higher.
.3 Ballasts shall meet all applicable ANSI and IEEE standards regarding harmonic distortion, and as a minimum, input current THD content shall be less than 10%.
.4 Ballasts shall not be affected by lamp failure, and shall yield normal lamp life.
.5 Lamp current crest factor shall not exceed 1.6.
.6 Power factor shall be minimum 99%.
.7 Ballast shall carry a minimum five year warranty.
.8 Input line amps shall be less than 0.53 for two F32T8 lamps (120 Volt).
.9 Maximum total ballast watts (2-F32T8 lamps) shall not exceed 63 input watts.
.10 Sound level rating shall be Class A.
.11 EMI/RFI emissions shall meet FCC CFR 47 Part 18 Subpart C Class A.
.12 Line transient / auto surge protection compliance with ANSI 62.41.
.13 Ballast factor: minimum 0.875.
.14 Mounting: Integral with luminaire.

2.3 FINISHES

.1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

2.4 LUMINAIRES

.1 Luminaire Schedule: Type A - 305 mm x 1219 mm recessed fluorescent fixture suitable for T-bar ceiling. Two 32 W T8 lamps. Features: - Efficiency - 78.6% -102 mm deep -flush steel full sized door frame with mitered corner detailing -acrylic lens (2.41 mm pattern 12).

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Locate and install luminaires as indicated.

.2 Provide adequate support to suit ceiling system.

.3 Provide plaster frame and trim as required, and turn over to trade providing ceiling installation.

.4 Support luminaires directly from building structure.

.5 Provide low temperature rated ballasts for exterior installations.

.6 Install recessed fluorescent luminaires so that they can be completely removable from below the finished ceiling.

.7 Recessed lighting luminaires in inaccessible ceilings shall be secured to blocking attached to building structure.

.8 Where no finished ceiling exists, luminaires shall be suspended on rigid conduit hangers complete with ball aligner, and outlet box canopy. All suspension components shall be degreased and painted white, unless otherwise noted.

.9 Replace ballasts, which in the opinion of The Departmental Representative, are found to exhibit excessive noise.

.10 Coordinate installation of luminaires with Divisions 22, 23 and 24 to avoid conflicts between luminaires, and mechanical system components.

.11 A maximum of two fluorescent luminaires recessed in t-bar shall be energized from one junction box mounted on the underside of the structural ceiling. A separate armoured cable drop shall be provided for each luminaire. Length of drop shall be adequate to allow relocation of luminaire one tile in all directions from its specified location.

3.2 WIRING

.1 Connect luminaires to lighting circuits:
.1 Install flexible or rigid conduit for luminaires as indicated.

3.3 LUMINAIRE SUPPORTS

.1 For suspended ceiling installations support luminaires independently of ceiling.

3.4 LUMINAIRE ALIGNMENT

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.5 CLEANING

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

END OF SECTION

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

.1 Empty telecommunications raceways system consists of outlet boxes, cover plates, conduits, pull boxes, sleeves and caps, fish wires, service chases, service fittings.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20.

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

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal, conduit and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

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

PART 2 - PRODUCTS

2.1 MATERIAL

.1 Conduits: EMT type, in accordance with Section 26 05 34.

.2 Junction boxes: in accordance with Section 26 05 31.

.3 Outlet boxes, conduit boxes, and fittings: in accordance with Section 26 05 31.

.4 Fish wire: polypropylene type.

PART 3 - EXECUTION

3.1 INSTALLATION .1 Install empty raceway system, including distribution system, fish wire, outlet boxes, pull boxes, cover plates, conduit, sleeves and caps, miscellaneous and positioning material to constitute complete system.

END OF SECTION

PART 1 - GENERAL

1.1 PURPOSE

.1 To verify that installations are in accordance with project requirements.

.2 To ensure proper system operation.

1.2 COMMISSIONING ORGANIZATIONS

.1 Certified member of ECAO or CFAA.

1.3 RELATED SECTIONS

.1 Section 01 91 00 - Commissioning.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 PROCEDURES

.1 Follow manufacturer's recommendations for testing.

.2 Inspect wiring connections to all devices comprising the system.

.3 Verify supervision of wiring at every device connection to a supervised circuit.

.4 Test operation of every device on a system to verify its function.

.5 Examine equipment for any apparent damage or tampering that may interfere with its intended operation.

.6 Test equipment with capabilities for field adjustment to establish that it functions as intended under the conditions prevailing at its point of installation.

.7 Examine devices for evidence of damage or obstructions which may interfere with their operating mechanisms.

.8 Wiring:

.1 Inspect every device and test to demonstrate that disconnection of the device from the circuit or malfunction of the equipment or wiring activates the required supervisory signals. Inspection shall include verification that:

.1 Supervisory signals operate in response to open circuits, short circuits, ground faults and disconnection of plug-in components;

.2 Terminations of conductors entering and leaving equipment have been made;

.3 Circuit polarities are in accordance with the system design, where applicable.

.2 In addition, test to establish that the power supplied to any device is within its recommended operating range and that the required voltage levels are maintained and that the fusing is correct.

.9 Alarm signals - audible:

.1 Test on main power supply and standby power supply with the maximum expected load on the system.

.2 The audible signalling appliances shall function as intended and shall be audible throughout the building over the background noise present.

.3 Decibel recordings in each are covering 100 sq. metres shall be taken.

.4 The level of sound should usually be 15 db above ambient noise level.

.10 Control equipment and transponders:

.1 Commissioning Report:

.1 Provide in accordance with requirements of Section 01 91 00, supplemented as specified herein.

.2 Report to include relevant information of the system including:

.3 Each system part described.

.4 How the system is operated.

.5 What functions the system performs.
.6 Requirements for tests and service.
.7 Itemization of all devices connected on the system, their general location.
.8 The date of the performed tests.
.9 All pertinent details of the report sheets requested.

.2 Verification:
.1 The Commissioning Report to be submitted to the Commissioning Manager upon completion of commissioning and will be subject to verification by the Commissioning Manager.

.11 Testing shall be done in accordance to CAN/ULC S537-2013 Verification of Fire Alarm Systems. Provide verification report and certification.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:
.1 Materials and installation for fire alarm systems.

1.2 REFERENCES

.1 Government of Canada
.1 TB OSH Chapter 3-03, 1997-01-28, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-03, Standard for Fire protection Electronic Data Processing Equipment.
.2 TB OSH Chapter 3-04, 1994-12-22, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.3 Underwriter's Laboratories of Canada (ULC)
.1 CAN/ULC-S524-14, Standard for the Installation of Fire Alarm Systems.
.2 CAN/ULC-S525-07, Audible Signal Device for Fire Alarm Systems.
.3 Testing shall be done to CAN/ULC S537-2013 Verification Fire Alarm Systems.

.4 National Fire Protection Agency
.1 NFPA 72-2007, National Fire Alarm Code.
.2 NFPA 90A-2009, Installation of Air Conditioning and Ventilating Systems.

1.3 QUALITY ASSURANCE

.1 Qualifications:
.1 Installer: company or person specializing in fire alarm system installations with 5 -years documented 5 years experience approved by manufacturer.

.2 Provide services of representative or technician from manufacturer of system, experienced in installation and operation of type of system being provided, to supervise installation, adjustment, preliminary testing, and final testing of system and to provide instruction to project personnel.

.3 System:
.1 To TB OSH Chapter 3-04.
.2 Subject to Fire Commissioner of Canada (FC) approval.
.3 Subject to FC inspection for final acceptance.

.4 Maintenance Service:
.1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC- S536. Submit inspection report to Departmental Representative.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with Section 01 61 00.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:
.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 AUDIBLE SIGNAL DEVICES

.1 Audible device(s):
.1 Audible device to be reused.

2.2 WIRING

.1 Wire for audible appliances: No.14 AWG minimum F.A.S. cable copper conductor.

2.3 AS-BUILT RISER DIAGRAM

.1 Fire alarm system riser diagram: in glazed frame on black lamicoid sheet with bevelled edges, white lettering and designations, minimum size 600 x 600 mm.

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 systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-04.

.2 Remove redundant heat detectors as indicated on drawings. Remove associated redundant conduit and wiring to last and first respective devices outside area of construction. Then make circuit good extend new conduit and wiring as required.

.3 Connect alarm circuits to main control panel.

.4 Locate and install signal devices and connect to signalling circuits.

.5 Connect signalling circuits to main control panel.

.6 Provide revised end of line resistor as required.

.7 Connect fire suppression systems to control panel.

3.3 FIELD QUALITY CONTROL

.1 Site Tests:
.1 Perform tests in accordance with Section 26 05 00 and CAN/ULC-S537.
.2 Fire alarm system:
.1 Test each alarm circuit.

.2 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.

.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 Verification requirements in accordance with Section 01 47 17, include:
.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource reuse.
.5 Recycled content.
.6 Local/regional materials.
.7 Low-emitting materials.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11.

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

END OF SECTION