Public Works and
Government Services Canada

Requisition No. EZ899-190704

DRAWINGS & SPECIFICATIONS
for

Kent Institution
96 Beds LU Domestic Hot Water Retrofit
R.087167.001

APPROVED BY:

A/ Regional Manager, AES — 2018-04-23 Date

Construction Safety Coordinator — 18.06.20 Date

TENDER:

Project Manager — JUN 20, 2018 Date

Real Property Services Branch, Professional and Technical Services, Pacific Region
Room 219 - 800 Burrard Street, Vancouver, B.C. V6Z 0B9

CONSULTANTS – SEAL & SIGNATURE

Discipline	**Seal / Signature / Date**
Mechanical (Prime)	PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA D. RADOICIC 20180411
Electrical	PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA Z. CHEN # 35045 2018-04-10
Architectural	REGISTERED ARCHITECT TONY Y. W. YIP APR 10 2018 BRITISH COLUMBIA
Structural	PROVINCE OF BRITISH COLUMBIA Y. W. P. LAM PROFESSIONAL ENGINEER # 14686 DESIGNATED STRUCTURAL ENGINEER Apr 12 2018

END OF SECTION

END OF SECTION

Mechanical Drawings:

M-001	SITE PLAN, GENERAL NOTES, MECHANICAL LEGEND, MECHANICAL DRAWING LIST
M-002	SITE PHOTOS – 1
M-003	SITE PHOTOS – 2
M-004	MECHANICAL SCHEMATICS – HVAC DEMOLITION
M-005	MECHANICAL SCHEMATICS – HVAC NEW
M-101	MECHANICAL LEVEL 3 LOWER MECHANICAL ROOM – HVAC DEMOLITION
M-102	MECHANICAL LEVEL 3 LOWER MECHANICAL ROOM – HVAC NEW
M-103	MECHANICAL ROOF PLAN – HVAC DEMOLITION AND NEW
M-201	MECHANICAL LEVELS 1, 2, AND SERVICE CORRIDOR FLOOR PLAN AND DETAILS – PLUMBING DEMOLITION AND NEW
M-301	MECHANICAL DETAILS

Electrical Drawings:

E-100	SITE PLAN, LEGEND, GENERAL NOTES, AND DRAWING LIST
E-200	ELECTRICAL ROOF PLAN DEMOLITION & NEW
E-300	ELECTRICAL LEVEL 3 MECHANICAL ROOM PLAN EXISTING & NEW
E-400	ELECTRICAL SCHEDULE

Architectural Drawings:

A-101	ROOF PLAN – DEMOLITION & NEW
A-102	LEVEL 3 MECHANICAL ROOM FLOOR PLAN – DEMOLITION & NEW
A-103	DETAILS

Structural Drawings:

S-100	STRUCTURAL GENERAL NOTES, PLANS & SECTIONS

END OF PROJECT DRAWING LIST

Part 1 General

1.1 SUMMARY OF WORK

.1 Work covered by Contract Documents:

.1 This Contract covers the following work at the Kent Institution in Agassiz, BC, for the project R.087167.001 96 Beds LU DHW Retrofit.

.2 Refer to Section 01 11 00 Summary of Work.

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

.1 Provide a detailed work plan including a project schedule and construction phasing strategy for the project. This detailed work plan shall be submitted to the Departmental Representative for review to verify that there will be no interruption of service.

.2 Do not start work until all essential equipment is delivered to the site and the work can proceed without delays.

.3 Provide as-built drawings and closeout submittals.

.4 Refer to Section 00 01 11 Project Drawing List.

.3 Contractor's Use of Premises:

.1 Contractor has limited use of site for work of this contract until Substantial Completion:

.1 Contractor use of premises for storage and access, as approved by the Departmental representative.

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

.2 Vehicular access will be restricted during the inmate "count" at breakfast, lunch, and dinner hours. Confirm times with Departmental Representative. Delays may occur when entering and exiting the Institution with vehicles due to security situations and heavy traffic.

1.2 WORK RESTRICTIONS

.1 Service Interruptions

.1 Notify Departmental Representative of intended interruption of power, communication and water services and provide schedule of interruption times.

.2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of services throughout course of work. Keep duration of interruptions to a minimum. Coordinate interruptions with local authority having jurisdiction and local residences and businesses affected by the disruption.

.2 Access & Egress: Provide for access by pedestrian and vehicular traffic on and around site where work is in progress.

.3 Use of Site and Facilities

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

.2 Maintain existing services where indicated and provide for personnel and vehicle access.

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

.4 Contractor to provide sanitary facilities. Keep facilities clean.

.5 Closures: protect Work temporarily until permanent enclosures are completed.

.5 Security Requirements: refer to Section 01 14 10 - Security Requirements.

.6 Hours of work:

.1 Perform work during normal working hours of the Institution 07:30 to 16:00, Monday through Friday except holidays.

.2 When it is necessary, arrange in advance with Departmental Representative to work outside of normal working hours.

1.3 CONSTRUCTION WORK SCHEDULE

.1 Commence work immediately upon official notification of acceptance of offer and complete the work within 48 weeks from the date of such notification.

.2 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Substantial Certificate and Final Certificate as defined times of completion are of essence of this contract.

.3 Submittal:

.1 Submit to Departmental Representative within 10 working days of Award of Contract, a Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of construction progress.

.2 Identify each trade or operation.

.3 Show dates for delivery of items requiring long lead time.

.4 Departmental Representative will review schedule and return one copy.

.5 Re-submit two (2) copies of finalized schedule to Departmental Representative within five (5) working days after return of reviewed preliminary copy.

.4 Project Scheduling Reporting:

.1 Update Project Schedule on bi-weekly basis reflecting activity changes and completions, as well as activities in progress.

.2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

.5 Project Meetings:

.1 Discuss Project Schedule at bi-weekly site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.

.2 Weather related delays with their remedial measures will be discussed and negotiated.

.3 Before submitting first progress claim submit breakdown of Contract price in detail as directed by Departmental Representative and aggregating contract price. Breakdown shall be provided for this project. After approval by Departmental Representative cost breakdown will be used as basis for progress payments. Only PWGSC paper work is acceptable.

1.4 SUBMITTAL PROCEDURES

.1 Specified in Section 01 33 00.

1.5 HEALTH AND SAFETY

.1 Specified in Section 01 35 33.

1.6 ENVIRONMENTAL PROCEDURES

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

.2 Do not bury rubbish and waste materials on site unless approved by Departmental Representative.

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

.4 Provide temporary drainage and pumping as necessary to keep excavations and site free from water during excavation and grading activities.

.5 Control disposal of run-off of water containing suspended materials or other harmful substances in accordance with local authority requirements. Construct settlement ponds and silt fences as required by the Provincial Environmental authority.

.6 Cover or wet down dry materials and rubbish to prevent blowing dust and debris.

.7 Under no circumstances dispose of rubbish or waste materials on adjoining property.

1.7 REGULATORY REQUIREMENTS

.1 References and Codes:

.1 Perform Work in accordance with National Building Code of Canada (NBCC-2015) 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.

1.8 QUALITY CONTROL

.1 Specified in Section 01 45 00.

1.9 TEMPORARY UTILITIES

.1 Installation and Removal:

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

.2 Remove from site all such work after use.

.6 Fire Protection:

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

1.10 CONSTRUCTION FACILITIES

.1 Installation and Removal:

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

.2 Remove from site all such work after use.

.3 Hoisting:

.1 Provide, operate and maintain hoists required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof.

.2 Hoists to be operated by qualified operator.

.4 Site Storage/Loading:

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

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

.5 Construction Parking:

.1 Make good damage to existing roads used for access to project site.

.2 Build and maintain temporary access where required and provide snow removal during period of Work.

.3 Park vehicles outside perimeter fence in designated parking areas.

.6 Contractor's Site Office and enclosure:

.1 Provide office of size to accommodate site meetings and Contractor's operations.

.2 Provide a clearly marked and fully stocked first-aid case in a readily available location.

.3 Provide temporary fenced area to enclose site and operations.

.7 Equipment, Tools and Material 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.

.8 Sanitary Facilities:

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

.2 When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures. Permanent facilities may be used on approval of Departmental Representative.

1.11 TEMPORARY BARRIERS AND ENCLOSURES

.1 Hoarding:

.1 Erect temporary site enclosure using new 1.8 m high temporary construction fencing. Provide lockable truck gate. Maintain fence in good repair.

.2 Enclosure of Structure:

.1 Provide temporary weathertight enclosures and protection for exterior openings until permanently enclosed. Design enclosures to withstand wind pressure. Provide lockable entry as required for moving personnel equipment and materials.

.2 Provide temporary enclosures to secure building from entry of unauthorized personnel during construction period.

.3 Guardrails and Excavations:

.1 Provide secure, rigid guard rails and barricades around deep excavations, open edges of floors and roofs etc.

.2 Provide as required by governing authorities.

.4 Access to Site:

.1 Maintain immediate local access roads in clean condition used during work of this contract.

.5 Protection for Off-Site and CSC Property:

.1 Protect surrounding CSC property from damage during performance of Work.

.2 Be responsible for damage incurred.

.6 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.

1.12 COMMON PRODUCT REQUIREMENTS

.1 Specified in Section 01 61 00.

1.13 EXAMINATION AND PREPARATION

.1 Existing Services:

.1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.

.2 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Departmental Representative.

.2 Location of Equipment and Fixtures:

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

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

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

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

1.14 EXECUTION REQUIREMENTS

.1 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 may be exposed by uncovering work; maintain excavations free of water.

.2 Execution:

.1 Execute cutting, fitting, and patching including excavation and fill, 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.

.7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

.8 Cut rigid materials using purpose made saw or core drill. Pneumatic or impact tools not allowed on brittle materials without prior approval.

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

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

.11 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material, full thickness of the construction element.

.12 Refinish surfaces to match adjacent finishes: For continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

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

1.15 CLEANING AND SPECIAL CLEANING PROCEDURES

.1 Specified in Section 01 74 11.

1.16 WASTE MANAGEMENT AND DISPOSAL

.1 Specified in Section 01 74 19.

1.17 GENERAL COMMISSIONING

.1 Commission installed systems prior to Demonstrations and Training.

.2 Specified in Section 01 91 13.

1.18 DEMONSTRATIONS AND TRAINING

.1 Specified in Section 01 91 41.

1.19 CLOSEOUT PROCEDURES

.1 Specified in Section 01 77 00.

1.20 CLOSEOUT SUBMITTAL

.1 Specified in Section 01 78 00.

END OF SECTION

Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract includes the following activities in Pod 2 at the Kent Institution in Agassiz, BC and further identified as the "Work":

.1 Work shall be completed as phased construction (refer to drawings).

.2 Improvements to DHW Heating Capacity by eliminating DHW pre-heat, (re-pipe the DHW tanks to operate in parallel, with a common DHW temperature set-point), provision of external heat exchangers (brazed type, double wall plate heat exchangers) for DHW heating. Removal of immersion heaters (after external heat exchangers are functional), and chlorination of the storage tanks before they are re-connected to the operating system.

.3 Addition of a pump set to facilitate heating of the domestic water and serve as backup,

.4 Replacement of domestic water recirculation pumps.

.5 Separation of a Shower Riser from Washroom Riser, in Pod 2, as indicated.

.6 Replacement of the fan coils serving the operations centre, and provision of direct expansion (DX) refrigerant based independent cooling system for those zones.

.7 Provision of an air cooled chiller, including roof curbs and supports.

.8 Provision of the associated chilled water pumps and controls

.9 Removal of redundant piping and equipment (heat recovery chillers, condenser water pumps, condenser water buffer tank and associated piping, including glycol mixing tank) - minimizes clutter in the mechanical room.

.10 Relocation of domestic water expansion tank, and the hot water sidestream filter and pot-feeder.

.11 Adjustment to existing controls and Building Automation System (BAS) to maintain the appropriate operational sequences and set-points.

.12 Remove and dispose of hazardous building materials that that may be encountered or disturbed during construction as outlined in Division 2. Hazardous building materials include but are not limited to asbestos containing, pipe elbows, and plumbing gaskets.

1.2 WORK SEQUENCE

.1 Work shall be completed as phased construction, while maintaining existing systems operational.

.2 Provide a schedule with particular regard to phasing requirements. Maintain and update schedule regularly and report to the facility representative and the construction team. Phasing suggestions identified on the drawings will be used as basis for developing construction schedule.

.3 Maintain systems operational at all times. Note that the facility remains fully functional, and requires domestic hot and cold water, heating and cooling services continuously, and throughout the construction period.

.4 Some components need to be timed with seasonal weather changes (e.g. chiller shutdown), and sequenced (e.g. one boiler system relocated and made active before shutting down the second).

.5 Allow time to confirm a phase functional prior to proceeding with the next phase.

.6 Coordinate with facility representatives. Provide minimum 72 hours notice and maintain "two week look-ahead schedule" for coordination with facility operators. Regularly submit to the facility representative and the construction team.

.7 Facility representatives may request re-scheduling of some activities (for operational requirements). Reasonable adjustments to scheduling by the facility representative will not be considered grounds for additional cost claims.

.8 Construction period shall include commissioning scope and submission of close-out documents. Refer to Section 01 01 50 General Instructions (CSC).

.9 Maintain fire access/control.

1.3 CONTRACTOR USE OF PREMISES

.1 Access to this site is restricted and will need to be coordinated with the facility's site officer to perform the work.

.2 Co-ordinate use of premises under direction of Departmental Representative.

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

1.4 EXISTING SERVICES

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

.2 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active services including power and communications services. Adhere to approved schedule and provide notice to affected parties.

1.5 DOCUMENTS REQUIRED

.1 Maintain at job site, one copy of each document as follows:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Reviewed Shop Drawings.

.5 List of Outstanding Shop Drawings.

.6 Change Orders.

.7 Other Modifications to Contract.

.8 Field Test Reports.

.9 Copy of Approved Work Schedule.

.10 Health and Safety Plan and Other Safety Related Documents.

.11 Other documents as specified.

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 PURPOSE

.1 To ensure that both the construction project and the institutional operations may proceed without undue disruption or hindrance and that the security of the Institution is maintained at all times.

1.2 PURPOSE

.1 "Contraband" means:

.1 an intoxicant, including alcoholic beverages, drugs and narcotics

.2 a weapon or a component thereof, ammunition for a weapon, and anything that is designed to kill, injure or disable a person or that is altered so as to be capable of killing, injuring or disabling a person, when possessed without prior authorization,

.3 an explosive or a bomb or a component thereof,

.4 currency over any applicable prescribed limit, $25.00, and

.5 any item not described in paragraphs (.1) to (.4) above that could jeopardize the security of a Penitentiary or the safety of persons, when that item is possessed without prior authorization.

.2 Unauthorized smoking and related items means all smoking items including, but not limited to, cigarettes, cigars, tobacco, chewing tobacco, cigarette making machines, matches and lighters.

.3 "Commercial Vehicle" means any motor vehicle used for the shipment of material, equipment and tools required for the construction project.

.4 "CSC" means Correctional Service Canada.

.5 "Director" means Director or Warden of the Institution as applicable or their representative.

.6 "Construction employees" means persons working for the general contractor, the sub-contractors, equipment operators, material suppliers, testing and inspection companies and regulatory agencies.

.7 "Departmental Representative" means the Public Works and Government Services Canada representative defined in General Conditions.

.8 "Perimeter" means the fenced or walled area of the institution that restrains the movement of the inmates.

.9 "Construction zone" means the area, as indicated in the contract documents, that the contractor will be allowed to work". This area may or may not be isolated from the security area of the institution. Limits to be confirmed at construction start-up meeting.

1.3 PRELIMINARY PROCEEDINGS

.1 At construction start-up meeting:

.1 Discuss the nature and extent of all activities involved in the Project.

.2 Establish mutually acceptable security procedures in accordance with this instruction and the institution's particular requirements.

.2 The Contractors' responsibilities:

.1 Ensure that all construction employees are aware of the CSC security requirements.

.2 Ensure that a copy of the CSC security requirements is always prominently on display at the job site.

.3 Co-operate with institutional personnel in ensuring that security requirements are observed by all construction employees.

1.4 CONSTRUCTION EMPLOYEES

.1 Submit scanned copy of government issued ID for each employee to the Departmental Representative to obtain gate pass.

.2 Allow 10 working days for processing of gate passes. Employees will not be admitted to the Institution without a gate pass in place and a recent picture identification such as a provincial driver's license.

.3 The Director may require that facial photographs may be taken of construction employees and these photographs may be displayed at appropriate locations in the institution or in an electronic database for identification purposes. The Director may require that Photo ID cards be provided for all construction workers. ID cards will then be left at the designated entrance to be picked upon arrival at the institution and shall be displayed prominently on the construction employees clothing at all time while employees are at the institution.

.4 Entry to Institutional Property will be refused to any person there may be reason to believe may be a security risk.

.5 Any person employed on the construction site will be subject to immediate removal from Institutional Property if they:

.1 appear to be under the influence of alcohol, drugs, or narcotics.

.2 behave in an unusual or disorderly manner.

.3 are in possession of contraband.

1.5 VEHICLES

.1 All unattended vehicles on CSC property must have windows closed; fuel caps locked, doors and trunks locked and keys removed. The keys must be securely in the possession of the owner or an employee of the company that owns the vehicle.

.2 The director may limit at any time the number and type of vehicles allowed within the Institution.

.3 Drivers of delivery vehicles for material required by the project will require security clearances and must remain with their vehicle the entire time that the vehicle is in the Institution. The director may require that these vehicles be escorted by Institutional staff or PWGSC Construction Escorts while in the Institution.

.4 If the Director permits trailers to be left inside the secure perimeter of the Institution, the trailer doors must be locked at all times. All windows must be securely locked bars when left unoccupied. Cover all windows with expanded metal mesh. When not in use lock all storage trailers located inside and outside the perimeter. All storage trailers inside and outside the perimeter must be locked when not in use.

1.6 PARKING

.1 The parking area(s) to be used by construction employees will be designated by the Director. Parking in other locations will be prohibited and vehicles may be subject to removal.

1.7 SHIPMENTS

.1 To avoid confusion with the institution's own shipments, address all shipments of project material, equipment and tools in the Contractor's name and have a representative on site to receive any deliveries or shipments. CSC or PWGSC staff will **NOT** accept receipt of deliveries or shipments of any material equipment or tools for the contractor.

1.8 TELEPHONES

.1 The installation of telephones, facsimile machines and computers with Internet connections is not permitted within the Institution perimeter unless prior approved by the Director.

.2 The Director will ensure that approved telephones, facsimile machine and computers with Internet connections are located where they are not accessible to inmates. All computers will have an approved password protection that will stop an Internet connection to unauthorized personnel.

.3 Wireless cellular and digital telephones, including but not limited to devices for telephone messaging, pagers, Blackberries, PDAs, telephone used as 2-way radios are not permitted within the Institution unless approved by the Director. If wireless cellular telephones are permitted, the user will not permit their use by any inmate.

.4 The Director may approve but limit the use of 2-way radios.

1.9 WORK HOURS

.1 Work hours within the Institution are generally 7:30am to 16:00 with some exceptions. Refer to Division 1 and coordinate with Director for exceptions.

.2 Work is not permitted during weekends and statutory holidays without the permission of the Director. A minimum of seven days advance notice will be required to obtain the required permission. In case of emergencies or other special circumstances, this advance notice may be waived by the Director.

1.10 OVERTIME WORK

.1 Conform to Division 1.

.2 Provide 48 hours advance notice to Director for all work to be performed after normal working hours of the Institution. Notify Director immediately if emergency work is required, such as to complete a concrete pour or make the construction site safe and secure.

1.11 TOOLS AND EQUIPMENT

.1 Maintain a complete list of all tools and equipment to be used during the construction project. Make this inventory available for inspection when required by the Institution.

.2 Throughout the construction project maintain up-to-date the list of tools and equipment specified above.

.3 Keep all tools and equipment under constant supervision, particularly power-driven and cartridge-driven tools, cartridges, files, saw blades, rod saws, wire, rope, ladders and any sort of jacking device.

.4 Store all tools and equipment in approved secure locations.

.5 Lock all tool boxes when not in use; Keys to remain in the possession of the employees of the contractor. Secure and lock scaffolding when not erected and when erected Secure in a manner agreed upon with the Institution designate.

.6 Report all missing or lost tools or equipment immediately to the Departmental Representative/Director.

.7 The Director will ensure that the security staff members carry out checks of the Contractor's tools and equipment against the list provided by the Contractor. These checks may be carried out at the following intervals:

.1 At the beginning and conclusion of every work day or shift upon entering and exiting the Institution.

.2 At any time when contractor is on Institution property.

.8 Certain tools/equipment such as cartridges and hacksaw blades are highly controlled items. The contractor will be given at the beginning of the day, a quantity that will permit one day's work. Used blades/cartridges will be returned to the Director's representative at the end of each day. Maintain up to date inventory of all used blades/cartridges.

.9 If propane or natural gas is used for temporary heating during construction, the institution will require that the contractor supervise the construction site during non-working hours.

1.12 KEYS

.1 Security Hardware Keys.

.1 Arrange with the security hardware supplier/installer to have the keys for the security hardware to be delivered directly to Institution, specifically the Security Maintenance Officer (SMO).

.2 The SMO will provide a receipt to the Contractor for security hardware keys.

.3 Provide a copy of the receipt to the Departmental Representative.

.2 Other Keys

.1 Use standard construction cylinders for locks for his use during the construction period.

.2 Issue instructions to employees and sub-trades, as necessary, to ensure safe custody of the construction set of keys.

.3 Upon completion of each phase of the construction, the CSC representative will, in conjunction with the lock manufacturer:

.1 Prepare an operational keying schedule

.2 Accept the operational keys and cylinders directly from the lock manufacturer.

.3 Arrange for removal and return of the construction cores and install the operational core in all locks.

.4 Upon putting operational security keys into use, the PWGSC construction escort will obtain these keys as they are required from the SMO and open doors as required by the Contractor. The Contractor shall issue instructions to his employees advising them that all security keys shall always remain with the PWGSC construction escort.

1.13 SECURITY HARDWARE

.1 Turn over all removed security hardware to the Director of the Institution for disposal or for safekeeping until required for re-installation.

1.14 PRESCRIPTION DRUGS

.1 Employees of the contractor who are required to take prescription drugs during the workday shall obtain approval of the Director to bring a one day supply only into the Institution.

1.15 SMOKING RESTRICTIONS

.1 Smoking is not permitted inside correctional facilities or outdoors within the perimeter of a correctional facility and persons must not possess unauthorized smoking items within the perimeter of a correctional facility.

.2 Persons in violation of this policy will be requested to immediately cease smoking or dispose of any unauthorized smoking items and, if they persist will be directed to leave the Institution.

.3 Smoking is permitted outside the perimeter of a correctional facility in an area designated by the Director.

1.16 CONTRABAND

.1 Weapons, ammunition, explosives, alcoholic beverages, drugs and narcotics are prohibited on institutional property.

.2 The discovery of contraband on the construction site and the identification of the person(s) responsible for the contraband shall be reported immediately to the Director.

.3 Contractors should be vigilant with both their staff and the staff of their sub-contractors and suppliers that the discovery of contraband may result in cancellation of the security clearance of the affected employee. Serious infractions may result in the removal of the company from the Institution for the duration of the construction.

.4 Presence of arms and ammunition in vehicles of contractors, sub-contractors and suppliers or employees of these will result in the immediate cancellation of security clearances for the driver of the vehicle.

1.17 SEARCHES

.1 All vehicles and persons entering institutional property may be subject to search.

.2 When the Director suspects, on reasonable grounds, that an employee of the Contractor is in possession of contraband, he may order that person to be searched.

.3 All employees entering the Institution may be subject to screening of personal effects for traces of contraband drug residue.

1.18 ACCESS AND REMOVAL FROM INSTITUTION PROPERTY

.1 Construction personnel and commercial vehicles will not be admitted to the institution after normal working hours, unless approved by the Director.

1.19 MOVEMENT VEHICLES

.1 Construction vehicles are not to leave the Institution until an inmate count is completed. Escorted commercial vehicles will be allowed to enter or leave the institution through the vehicle access gate during the following hours:

.1 AM: 0745 hrs. to 1100 hrs.

.2 PM: 1300hrs. to 1530 hrs.

.2 The contractor will advise the Director twenty four (24) hours in advance to the arrival on the site of heavy equipment such as concrete trucks, cranes, etc.

.3 Vehicles being loaded with soil or other debris, or any vehicle considered impossible to search, must be under continuous supervision by CSC staff or PWGSC construction escorts working under the authority of the Director.

.4 Commercial vehicles will only be allowed access to institutional property when their contents are certified by the Contractor or his representative as being strictly necessary to the execution of the construction project.

.5 Vehicles will be refused access to institutional property if, in the opinion of the Director, they contain any article which may jeopardize the security of the institution. Arrange with Director for parking of contractor's vehicles.

.6 Private vehicles of construction employees will not be allowed within the security wall or fence without the authorization of the Director.

.7 With the approval of the Director, certain equipment may be permitted to remain on the construction site overnight or over the weekend. This equipment must be securely locked, with the battery removed. The Director may require that the equipment be secured with a chain and padlock to another solid object.

1.20 MOVEMENT OF CONSTRUCTION EMPLOYEES ON INSTITUTIONAL PROPERTY

.1 Subject to the requirements of good security, the Director will permit the Contractor and his employees as much freedom of action and movement as is possible.

.2 However, notwithstanding paragraph above, the Director may:

.1 Prohibit or restrict access to any part of the institution.

.2 Require that in certain areas of the institution, either during the entire construction project or at certain intervals, construction employees

only be allowed access when accompanied by a member of the CSC security staff or PWGSC Construction Escort Officer.

.3 During the lunch and coffee/health breaks, all construction employees will remain within the construction site. Construction employees are not permitted to eat in the Institution cafeteria and dining room.

1.21 SURVEILLANCE AND INSPECTION

.1 Construction activities and all related movement of personnel and vehicles will be subject to surveillance and inspection by CSC security staff members to ensure that established security requirements are met.

.2 CSC staff members will ensure that an understanding of the need to carry out surveillance and inspections, as specified above, is established among construction employees and maintained throughout the construction project.

1.22 STOPPAGE OF WORK

.1 The director may request at any time that the contractor, his employees, sub-contractors and their employees not enter or leave the work site immediately due to a security situation occurring within the Institution. The contractor's site supervisor will note the name of the staff member giving the instruction, the time of the request and obey the order as quickly as possible.

.2 The contractor shall advise the Departmental Representative of this interruption of the work within 24 hours.

1.23 CONTACT WITH INMATES

.1 Unless specifically authorized, it is forbidden to come into contact with inmates, to talk with them, to receive objects from them or to give them objects. Any employee doing any of the above will be removed from the site and his security clearance revoked.

.2 Digital cameras (or any other type) are not allowed on CSC property.

.3 Notwithstanding the above paragraph, if the director approves of the use of cameras, it is strictly forbidden to take pictures of inmates, of CSC staff members or of any part of the Institution other than those required as part of this contract.

1.24 COMPLETION OF CONSTRUCTION PROJECT

.1 Upon completion of the construction project or, when applicable, the takeover of a facility, the Contractor shall remove all remaining construction material, tools and equipment that are not specified to remain in the Institution as part of the construction contract.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 78 00 - Closeout Submittals.

1.2 ADMINISTRATIVE

.1 Submit to Departmental Representative submittals listed for review. Submit with reasonable promptness and in orderly sequence so as to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Work affected by submittal shall not proceed 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 shall be 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 coordinated.

.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 Maintain a submittal log.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

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

.3 Allow 14 working days for Departmental Representative's review of each submission.

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

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

.6 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.

.7 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.

.11 Bill-of-Materials of all major components.

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

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

.10 Submit 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. Notwithstanding the foregoing, submit full shop drawings including but not limited to the following items: toilet partitions, washroom accessories (provide layout drawing), detention and commercial doors and frames, detention windows, and chain link fencing.

.11 Delete information not applicable to project.

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

.13 Shop drawings will be reviewed by the Departmental Representative for general conformance with the design concept of the project and general compliance with information given in the Contract Documents. The Departmental Representative will signify the status of the review by stamping and dating the electronic copy accordingly, in one of the following manners:

.1 Reviewed

.2 Reviewed as Noted

.3 Revise and Resubmit

.4 Not Reviewed

The Departmental Representative will return the electronic copy to the Contractor for their use and for copying for record keeping purposes and for distribution to Subcontractors and to suppliers.

.14 The Contractor shall distribute copies of the returned shop drawings by the Departmental Representative as **"Reviewed," "Reviewed as Noted"** to the Site Office and to the offices of Subcontractors, and suppliers.

.15 Shop drawings stamped **"Revise and Resubmit"** or **"Not Reviewed"** will be returned and shall be corrected and resubmitted to the Departmental Representative following the requirements stated above.

.16 Only shop drawings stamped **"Reviewed"** and **"Reviewed as Noted"** shall be used on the site and used for fabrication and installation of work. All other shop drawings shall be considered as being not reviewed and shall not be used on site or for fabrication and installation of work.

.17 Conform to review comments and stamped instructions of each shop drawing reviewed.

.18 Only drawings noted for revision and re-submission need be resubmitted. Include revisions required by previous reviews before re-submission of shop drawings.

.19 No new details or information shall be added to shop drawings after they have been fully reviewed.

.20 No work dependent on shop drawing information shall proceed until review is given and verification received from the Departmental Representative. Be responsible for work performed prior to receipt of reviewed shop drawings. No review comments shall be construed as authorization for Changes in the Work.

.21 Each Subcontractor or supplier shall fabricate work exactly as shown on shop drawings and if shop practice dictates revision, shall revise shop drawings and resubmit.

.22 File one copy of each finally revised and corrected shop drawing on site.

.23 Consider this article the minimum requirement. Further instruction contained in any particular specification section governs for that section of the Work.

.24 Shop drawings must be in Metric measurement.

.25 The review of shop drawings by the Departmental Representative is for sole purpose of ascertaining conformance with general concept. 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 all requirements of construction and Contract Documents. 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 all sub-trades.

.26 The Contractor will have a system in place to allow the Departmental Representative, Contractor and its Subcontractors to have electronic access to the project submittals, shop drawings, project communication and latest drawings on file through an internet site. The Contractor and its Subcontractors are required to access the system to obtain the latest drawings on which their shop drawings will be based. If shop drawings are submitted based on out dated drawings shop drawings will be returned without further action. The users of the electronic system, once entered into the system, will be informed electronically of updated drawings available to them on the system. Photo copies of the Departmental Representatives design drawings will not be accepted.

.27 The Departmental Representative's CADD files shall not be used by the Contractor, its Subcontractors or Suppliers for use in preparing shop drawings.

.28 A copy of final reviewed shop drawings in electronic format shall be included in operating and maintenance manuals specified under Section 01 78 00.

1.4 SAMPLES

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

.2 Deliver samples prepaid to site office.

.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 Price. 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.

1.5 CERTIFICATIONS

.1 When specified in individual specification sections, submit certification by manufacturer to the Departmental Representative to indicate material or Product conforms to or exceeds specified requirements.

.2 Certificates may be recent or previous test results on material or Product, but must be acceptable to the Departmental Representative.

1.6 MANUFACTURER'S FIELD REPORTS

.1 Submit reports for the Departmental Representative's benefit as contract administrator.

.2 Submit reports in duplicate within 10 days of observation, to the Departmental Representative for information.

.3 Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the Contract Documents.

1.7 PROGRESS DIARY

.1 Keep a permanent, written record on the site of the progress of the Work. Keep record open to the inspection of the Departmental Representative, and copies shall be furnished to the Departmental Representative upon request.

.2 The diary shall record all pertinent data such as:

.1 Daily weather conditions.

.2 Commencement, progress and completion of various portions of the Work.

.3 Dates of all site meetings.

.4 Dates of visits or inspections by government authorities, inspectors, utility companies and any other visitors to the site.

.5 Record of work force employed.

.6 Information required by Contractor or Subcontractor. Clarifications requested and answers received.

.7 Materials causing delay.

.8 Actions or events causing delay.

.3 Record of all quality control inspections and fire safety inspections including corrective actions taken.

1.8 PHOTOGRAPHS

.1 When requested by the Departmental Representative: Provide a electronic photographic record/history of the progress of the Work, per the Departmental Representative's instructions.

1.9 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Compensation Board status.

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

END OF SECTION

Part 1 General

PSPCC Update on Asbestos Use

Effective April 1, 2016, all Public Works and Government Services Canada (PWGSC) contracts for new construction and major rehabilitation will prohibit the use of asbestos-containing materials. Further information can be found at:

http://www.tpsgc-pwgsc.gc.ca/comm/vedette-features/2016-04-19-00-eng.html

1.1 REFERENCES

.1 Government of Canada.

.1 Canada Labour Code - Part II

.2 Canada Occupational Health and Safety Regulations.

.2 National Building Code of Canada (NBC):

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

.3 The Canadian Electric Code (as amended)

.4 Canadian Standards Association (CSA) as amended:

.1 CSA Z797-2009 Code of Practice for Access Scaffold

.2 CSA S269.1-1975 (R2003) Falsework for Construction Purposes

.3 CSA S350-M1980 (R2003) Code of Practice for Safety in Demolition of Structures

.4 CSA Z1006-10 Management of Work in Confined Spaces.

.5 CSA Z462- Workplace Electrical Safety Standard

.5 National Fire Code of Canada 2010 (as amended)

.1 Part 5 – Hazardous Processes and Operations and Division B as applicable and required.

.6 American National Standards Institute (ANSI):

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

.7 Province of British Columbia:

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

.2 Occupational Health and Safety Regulation

1.2 RELATED SECTIONS

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

.1 Section 01 01 50 General Instructions (CSC)

.2 Section 02 41 19 Selective Demolition

1.3 WORKERS' COMPENSATION BOARD COVERAGE

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

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

1.4 COMPLIANCE WITH REGULATIONS

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

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

1.5 SUBMITTALS

.1 Submit to Departmental Representative submittals listed for review in accordance with Section 01 33 00 Submittal Procedures.

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

.3 Submit the following:

.1 Health and Safety Plan.

.2 Copies of reports or directions issued by Federal and Provincial health and safety inspectors.

.3 Copies of incident and accident reports.

.4 Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Materials Information System (WHMIS) requirements.

.5 Emergency Procedures.

.4 The Departmental Representative will review the Contractor's site-specific project Health and Safety Plan and emergency procedures, and provide comments to the Contractor within 10 days after receipt of the plan. Revise the plan as appropriate and resubmit to Departmental Representative.

.5 Medical surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of work, and submit additional certifications for any new site personnel to Departmental Representative.

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

.1 Be construed to imply approval by the Departmental Representative.

.2 Be interpreted as a warranty of being complete, accurate and legislatively compliant.

.3 Relieve the Contractor of his legal obligations for the provision of health and safety on the project.

1.6 RESPONSIBILITY

.1 Assume responsibility as the Prime Contractor for work under this contract.

.2 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.

.3 Comply with and enforce compliance by employees with safety requirements of Contract documents, applicable Federal, Provincial, Territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.7 HEALTH AND SAFETY COORDINATOR

.1 The Health and Safety Coordinator (Registered Occupational Hygienist, Certified Industrial Specified Hygienist) must:

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

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

.3 Be on site during execution of work.

1.8 GENERAL CONDITIONS

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

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

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

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

1.9 PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:

.1 Multi-employer work site.

.2 Federal employees and general public.

.3 Energized electrical services.

.4 Working from heights

.5 Working in the open exposed to unpredictable weather.

.6 High volumes of vehicular and pedestrian traffic

1.10 UTILITY CLEARANCES

.1 The Contractor is solely responsible for all utility detection and clearances prior to starting the work.

.2 The Contractor will not rely solely upon the Reference Drawings or other information provided for utility locations.

1.11 REGULATORY REQUIREMENTS

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

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

1.12 WORK PERMITS

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

1.13 FILING OF NOTICE

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

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

1.14 HEALTH AND SAFETY PLAN

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

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

.1 Primary requirements:

.1 Contractor's safety policy.

.2 Identification of applicable compliance obligations.

.3 Definition of responsibilities for project safety/organization chart for project.

.4 General safety rules for project.

.5 Job-specific safe work, procedures.

.6 Inspection policy and procedures.

.7 Incident reporting and investigation policy and procedures.

.8 Occupational Health and Safety Committee/Representative procedures.

.9 Occupational Health and Safety meetings.

.10 Occupational Health and Safety communications and record keeping procedures.

.2 Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations which must be performed as part of the work.

.3 List hazardous materials to be brought on site as required by work.

.4 Indicate Engineering and administrative control measures to be implemented at the site for managing identified risks and hazards.

.5 Identify personal protective equipment (PPE) to be used by workers.

.6 Identify personnel and alternates responsible for site safety and health.

.7 Identify personnel training requirements and training plan, including site orientation for new workers.

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

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

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

1.15 EMERGENCY PROCEDURES

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

.1 Designated personnel from own company.

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

.3 Local emergency resources.

.4 Departmental Representative.

.2 Include the following provisions in the emergency procedures:

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

.2 Evacuate all workers safely.

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

.4 Notify the fire department or other emergency responders.

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

.6 Notify Departmental Representative.

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

.1 Work at high angles.

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

.3 Work with hazardous substances.

.4 Underground work.

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

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

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

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

1.16 HAZARDOUS PRODUCTS

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

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

.1 Advise Departmental Representative beforehand of the product(s) intended for use. Submit applicable MSDS and WHMIS documents as per Section 01 01 50.

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

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

.4 The contractor shall ensure that the product is applied as per manufacturers recommendations.

.5 The contractor shall ensure that only pre-approved products are brought onto the work site in an adequate quantity to complete the work.

1.17 ASBESTOS HAZARD

.1 Carry out any activities involving asbestos in accordance with applicable Provincial Regulations.

.2 Removal and handling of asbestos will be performed as indicated in Division 2 specifications.

1.18 PCB REMOVALS

.1 Mercury-containing fluorescent tubes and ballasts which contain polychlorinated biphenyls (PCBs) are classified as hazardous waste.

.2 Remove, handle, transport and dispose of as indicated in Division 2 specifications.

1.19 ELECTRICAL SAFETY REQUIREMENTS

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

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

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

1.20 ELECTRICAL LOCKOUT

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

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

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

1.21 OVERLOADING

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

1.22 FALSEWORK

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

1.23 SCAFFOLDING

.1 Design, construct and maintain scaffolding in a rigid, secure and safe manner, in accordance with CSA Z797-2009 Code of Practice for Access Scaffold and BC Occupational Health and Safety Regulations.

1.24 CONFINED SPACES

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

1.25 POWER-ACTUATED DEVICES

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

1.26 FIRE SAFETY AND HOT WORK

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

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

1.27 FIRE SAFETY REQUIREMENTS

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

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

.3 Portable gas and diesel fuel tanks are not permitted on most federal work sites. Approval from the Departmental Representative is required prior to any gas or diesel tank being brought onto the work site.

1.28 FIRE PROTECTION AND ALARM SYSTEM

.1 Fire protection and alarm systems shall not be:

.1 Obstructed.

.2 Shut off.

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

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

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

1.29 UNFORESEEN HAZARDS

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

1.30 POSTED DOCUMENTS

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

.1 Health and Safety Plan.

.2 Sequence of work.

.3 Emergency procedures.

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

.5 Notice of Project.

.6 Floor plans or site plans. Must be posted in a non-inmate access are and locked up when not being used.

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

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

.9 Material Safety Data Sheets (MSDS).

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

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

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

1.31 MEETINGS

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

1.32 CORRECTION OF NON-COMPLIANCE

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

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

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

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Inspection and testing, administrative, and enforcement requirements.

.2 Quality control program.

.3 Equipment and system adjust and balance.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 00 - Closeout Submittals.

1.3 GENERAL

.1 At Project commencement, establish quality assurance benchmarks and quality expectations for all workers and Subcontractors to follow.

.2 The Specification identifies a minimum level of quality, exceed this minimum level.

.3 Identify a person in the employ of the Contractor to monitor Work quality and to report quality assurance steps being taken, identified or discovered disparities, and corrective action taken.

.4 Submit written reports monthly to the Departmental Representative, to accompany progress claims.

.5 Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

.6 Comply with manufacturer's instructions, including each step in sequence. Should manufacturer's instructions conflict with Contract Documents, request clarification from Departmental Representative before proceeding.

.7 Comply with specified standards as minimum quality for the work except where more stringent tolerance, codes, or specified requirements indicate higher standards or more precise workmanship.

.8 Perform work with persons qualified to produce required and specified quality.

1.4 QUALITY CONTROL PROGRAM

.1 Prepare all test results in triplicate and provide copies of all tests concurrently to the Departmental Representative and Contractor.

.2 All test results shall specify at least the following data:

.1 Type of test.

.2 Dates of sampling, testing and reporting.

.3 Personnel involved.

.4 Location of test (with sketch if required).

.5 Specified requirements.

.6 Test results.

.7 Remarks regarding conformance with Contract Documents.

.3 Provide written test results to the Departmental Representative within 12 hours of tests. If the tests are completed on Site, provide the Departmental Representative with field memo summarizing results immediately following testing.

.4 Minimum testing requirements shall be in accordance with all applicable bylaws, regulations, standards, building codes and requirements of authorities having jurisdiction.

1.5 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.

1.6 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies will be engaged by the Contractor for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Contractor.

.1 Submit for approval by Departmental Representative proposed Independent Inspection/Testing Agencies.

.2 Provide equipment required for executing inspection and testing by appointed agencies.

.3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.

.4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and re-inspection.

1.7 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.

1.8 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.

1.9 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.

1.10 REPORTS

.1 Submit digital 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.

1.11 MILL TESTS

.1 Not applicable.

1.12 TEST AND MIX DESIGNS

.1 Not applicable.

1.13 MOCK-UPS

.1 Not applicable.

1.14 EQUIPMENT AND SYSTEMS

.1 Submit adjustment and balancing reports for plumbing systems. See Section 22 05 00 Plumbing - General.

END OF SECTION

Part 1 General

1.1 PRODUCTS/MATERIAL AND EQUIPMENT

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

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

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

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

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

metal in which they occur.

.1 Prevent electrolytic action between dissimilar metals.

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

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

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

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

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

.7 Types of washers as follows:

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

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

.3 Resilient washers: use with stainless steel.

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

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

.10 Store products in accordance with suppliers' instructions.

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

.1 Use primer or enamel to match original.

.2 Do not paint over nameplates.

1.2 QUALITY OF PRODUCTS

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

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

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

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

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

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

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

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

1.3 AVAILABILITY OF PRODUCTS

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

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

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

1.4 MANUFACTURER'S INSTRUCTIONS

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

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

.2 Obtain written instructions directly from the manufacturer.

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

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

1.5 CONTRACTOR'S OPTIONS FOR SELECTION OF PRODUCTS FOR TENDERING

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

.2 Products specified under "Acceptable Products": select any one of the indicated manufacturers, or any other manufacturer meeting or exceeding the Prescriptive specifications and indicated Products.

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

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

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

1.6 SUBSTITUTION AFTER CONTRACT AWARD

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

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

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

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

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

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

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

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

END OF SECTION

Part 1 General

1.1 RELATED SECTION

.1 Section 01 74 19 - Waste Management and Disposal.

.2 Section 01 77 00 - Closeout Procedures.

.3 Section 02 41 19 - Selective Demolition.

1.2 SPECIAL CLEANING

.1 Special cleaning requirements for existing construction, including existing work which will be covered up by new work and existing work to remain as is in the finished work.

1.3 REFERENCES

.1 Work Safe B.C. Regulations.

1.4 SPECIAL CLEANING PERFORMANCE REQUIREMENTS

.1 Existing building construction remaining part of the finished work will require a complete and thorough cleaning before installation of new construction and finishes. Existing construction remaining unaltered by the new work but forming part of the finished work is required to be cleaned.

.2 Cleaning includes but is not limited to all interior walls, floor and ceiling surfaces including concealed spaces such as attics, access floor, walls and soffits above accessible ceilings. Clean existing fittings, fixtures, equipment, doors, frames, electrical outlets, lights, cabinets, diffusers, panels, glazing, and metalwork.

.3 Remove all dirt, dust, sawdust, aggregate dust, mildew, moulds, fungus, insects and other foreign materials to return the existing surface to an as new condition as much as possible. Removal of permanent stains is not a requirement unless the stain is unsuitable for the application of new finishes or is odourous.

.4 The cleaning method selected will depend on the surface to be cleaned, its condition at the time of cleaning, the material to be removed by the cleaning process, and the requirements for new construction or finish to be applied.

.5 Cleaning methods can include but are not limited to hand cleaning, power tool cleaning. Steam cleaning and pressure washing are not acceptable in the existing institution.

.6 The method of cleaning and the cleaning products to be used will be left entirely to the discretion of the Contractor to suit the surface to be cleaned.

.7 Where the method is disruptive to the operation of the existing facility, review and obtain approval from the Departmental Representative. The Contractor is advised that the work will be carried out within an existing

operational building. The materials and processes must not disrupt the existing persons or operations within the institution. If required, the cleaning must be carried out on a schedule acceptable to the institution.

.8 The Contractor will be responsible for repair of finishes and materials damaged during cleaning where aggressive cleaning methods result in damage to finishes and materials.

.9 Prepare a test patch clean on a surface to be concealed prior to commencing work on an entire area or surface.

.10 The Contractor will be responsible for repair of damage or replacement of existing surfaces and finishes where in appropriate cleaning products and methods have been used.

.11 Where existing construction cannot be cleaned effectively by available cleaning methods obtain direction from the Departmental Representative.

.12 The requirements of this section are in addition to the requirements of specification trade sections which prescribe the preparation and/or acceptance of existing surfaces before the application of new finishes. Ensure that cleaning products to be used do not affect the occupants of the building and do not affect the application of new finishes to existing cleaned surfaces.

1.5 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris

.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 Provide and use clearly marked separate bins for recycling. Refer to Section 01 74 19 - Waste Management and Disposal.

.6 Remove waste material and debris from site and deposit in waste container at end of each working day.

.7 Dispose of waste materials and debris off site.

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

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

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

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

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

1.6 FINAL CLEANING

.1 When Work is Substantially Performed, remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.

.2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.

.3 Prior to final review, remove surplus products, tools, construction machinery and equipment.

.4 Remove waste products and debris including that caused by Departmental Representative 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, unless approved by Departmental Representative.

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

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

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

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

.10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.

.11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.

.12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.

.14 Remove dirt and other disfiguration from exterior surfaces.

.15 Clean and sweep roofs, gutters, areaways, and sunken wells.

.16 Sweep and wash clean paved areas.

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

.18 Clean roofs, downspouts, and drainage systems.

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

1.7 DEMOLISHED MATERIALS AND CONSTRUCTION WASTE

.1 The Contractor is responsible for ensuring that all materials are properly disposed of and that under no circumstances are demolished materials, construction waste, screws, fasteners, connectors and other similar items to be left in walls, ceilings, cavities, pockets, and voids.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for recycling or dispose of waste in accordance with:

Section 01 74 19 Waste Management and Disposal.

Section 02 41 19 Selective Demolition.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 01 50 – General Instructions (CSC).

.2 Section 02 41 19 – Selective Demolition.

.3 Section 01 14 10 – Security Requirements.

1.2 DEFINITIONS

.1 Materials Source Separation Program (MSSP): Consists of series of ongoing activities to separate reusable and recyclable waste material into material categories from other types of waste at point of generation.

.2 Recyclable: Ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse by others.

.3 Recycle: Process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.

.4 Recycling: Process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

.5 Reuse: Repeated use of product in same form but not necessarily for same purpose. Reuse includes:

.1 Salvaging reusable materials from re-modeling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.

.2 Returning reusable items including pallets or unused products to vendors.

.6 Salvage: Removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.

.7 Separate Condition: Refers to waste sorted into individual types.

.8 Source Separation: Acts of keeping different types of waste materials separate beginning from first time they became waste.

.9 Waste Audit (WA): Detailed inventory of materials in building. Involves quantifying by volume/weight amounts of materials and wastes generated during construction. Indicates quantities of reuse, recycling and landfill.

.10 Waste Reduction Workplan (WRW): Written report which addresses opportunities for reduction, reuse, or recycling of materials.

1.3 DOCUMENTS

.1 Maintain at job site, one copy of following documents:

.1 Waste Audit.

.2 Waste Reduction Workplan.

.3 Material Source Separation Plan.

1.4 MATERIALS SOURCE SEPARATION

.1 Before project start-up prepare Materials Source Separation Program (MSSP) and provide containers to deposit re-usable and/or recyclable materials of the following:

.1 Gypsum Board.

.2 Insulation.

.3 Acoustical ceiling panels.

.4 Metals.

.5 Wood.

.6 Cardboard.

.7 Plastics

.8 Other materials as indicated in technical sections.

.2 Submit before final payment summary of waste materials salvaged for reuse, recycling or disposal by project using deconstruction/disassembly material audit form:

.1 Provide receipts, scale tickets, waybills, and show quantities and types of materials reused, recycled, co-mingled and separated off-site or disposed of.

.2 For each material reused, sold or recycled from project, include amount and the destination.

.3 For each material land filled or incinerated from project, include amount of material and identity of landfill, incinerator or transfer station.

.3 Implement Materials Source Separation Program (MSSP) for waste generated on project in compliance with methods as approved by Departmental Representative.

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

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

.6 Provide inventory of quantities of demolition materials to be salvaged for reuse, recycling, or disposal.

1.5 DIVERSION OF MATERIALS

.1 Create a list of materials for separation from the general waste stream and stockpiled in separate containers, in compliance with fire regulations and to Departmental Representative's approval.

.2 Mark containers and provide instruction on disposal practices.

1.6 STORAGE, HANDLING AND APPLICATION

.1 Conform to Waste Reduction Work Plan.

.2 Handle waste materials not being reused, salvaged or recycled in accordance with authority having jurisdiction and fire regulations.

.3 Collect, handle, store on site and transport off-site, all materials in separated condition, to an approved and authorized recycling facility.

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

.5 Except as specified otherwise, materials removed from the site become the contractor's responsibility.

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

.7 Comply with site specific security requirements, per Section 01 14 10 Security Requirements (CSC).

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Administrative procedures preceding preliminary and final inspections of Work.

1.2 RELATED SECTIONS

.1 Section 01 78 00 - Closeout Submittals.

1.3 INSPECTION AND DECLARATION

.1 Project Phasing:

.1 The contractor shall submit a plan that inspects completed work at the completion of each phase, corrects the work prior to proceeding to the next phase of the work.

.2 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.

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

.4 Substantial Completion: submit written certificate that the 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.

.4 Certificates required by authorities having jurisdiction.

.5 Commissioning of all systems: Final commissioning reports have been submitted to the Departmental Representative.

.6 Operation of systems has been demonstrated to Departmental Representative's personnel.

.7 Work is complete and ready for Final Inspection.

.8 Close-out documents provided per Section 01 78 00 Closeout Submittals.

.5 Final Inspection: when items noted above are completed, request final inspection of Work by Departmental Representative. If Work is deemed incomplete by Department Representative, complete outstanding items and request re-inspection.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 45 00 – Quality Control

.2 Section 01 77 00 – Closeout Procedures

1.2 SUBMISSION

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

.2 Copy will be returned after final inspection, with Departmental Representative's comments.

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

.4 Two weeks prior to Interim Completion of the Work, submit to the Departmental Representative four final copies of operating and maintenance manuals in English.

.5 Hard copies of the Operating and Maintenance Manual are required as specified under clause 1.3. Provide four copies.

.6 Electronic PDF copy of the Operating and Maintenance Manual is required. Provide copy on CD or USB memory stick.

.7 Ensure spare parts, maintenance materials and special tools provided are new, un-damaged or defective, and of same quality and manufacture as products provided in Work.

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

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

.10 Pay costs of transportation.

1.3 FORMAT OF HARD COPY MANUALS

.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 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.

.9 Provide 1:1 scaled CAD files in dwg format on CD or USB memory stick.

.10 Provide PDF copy of final O&M manuals on CD or USB memory stick for insertion into hard copy.

1.4 CONTENTS - EACH VOLUME

.1 Table of Contents: provide title of project;

.1 date of submission;

.2 names, addresses, and telephone numbers of Contractor, Subcontractors, Suppliers with name of responsible parties;

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

.4 copy of hardware schedule and paint schedules, complete with the actual manufacturer, supplier and identification names and numbers.

.5 all extended guarantees, warranties, maintenance bonds, certificates, letters of guarantees, registration cards, as called for in the various sections of the specification.

.6 complete set of all final reviewed shop drawings.

.7 certificates of inspection by authorities having jurisdiction.

.8 test reports and certificates as applicable.

.9 complete set of as constructed drawings.

.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 - Quality Control.

.6 Record of Training: Refer to Section 01 91 41 – Commissioning Training.

1.5 'AS CONSTRUCTED' DRAWINGS AND SAMPLES

.1 In addition to requirements in General Conditions, maintain at the site one record copy of:

.1 Contract Drawings;

.2 Specifications;

.3 Addenda;

.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 As part of project close-out, submit

.1 Four (4) sets of printed as-constructed drawings, and electronic copy on CD or USB memory stick. File formats shall be in AutoCAD (latest version) and PDF.

.2 Submit one copy of check plots to Departmental Representative prior to final printing of as-constructed drawings.

.3 Departmental Representative will supply copies of the original AutoCAD files.

.4 Retain original logo and title block on the as-constructed drawings. Contractor may place on the upper right-hand title block area a small company logo, the text "AS-CONSTRUCTED" and the date.

.5 Costs for transferring as-constructed information from marked up working set of drawings to electronic format using AutoCAD and plotting service is included in the Contract.

1.6 RECORDING ACTUAL SITE CONDITIONS

.1 Record information on set of black line opaque drawings 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 Addenda and change orders.

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

1.7 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 all test and balancing reports.

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

1.8 MATERIALS AND FINISHES

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

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

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

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

1.9 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 Assemble parts as specified. Include part number, identification of equipment or system for which parts are applicable.

.4 Deliver to location as directed; place and store.

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

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

1.10 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 location as directed; place and store.

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

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

1.11 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 location as directed; place and store.

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

1.12 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 Departmental Representative's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.

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

.6 Co-execute submittals when required.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Related Sections

.1 Section 01 33 00 – Submittal Procedures.

.2 Section 01 91 31 – Commissioning Plan.

.3 Section 01 91 33 – Commissioning Forms.

.4 Section 01 91 41 – Commissioning Training.

.5 Section 23 08 00 – Mechanical Commissioning.

.6 Section 23 08 01 – Performance Verification.

.7 Section 26 05 00 – Common Work Results for Electrical.

.3 Acronyms:

.1 Cx - Commissioning

.2 CxA – Commissioning Authority (appointed by Departmental Representative)

.3 CxAg – Commissioning Agent (appointed by Mech. Contractor)

.4 CxMgr – Commissioning Manager (appointed by Prime Contractor)

.5 EMCS - Energy Monitoring and Control Systems.

.6 O M – Operating and Maintenance (staff)

.7 OMM - Operation and Maintenance Manuals

.8 PI - Product Information.

.9 PV - Performance Verification.

.10 TAB - Testing, Adjusting and Balancing.

1.2 REFERENCES

.1 CSA Standard Z320 -2011 Building Commissioning

.2 ASHRAE Standard 202-2013 Commissioning Process for Buildings and Systems

1.3 DEFINITIONS

.1 Commissioning Authority (CxA) – an individual identified by the Departmental Representative to lead the commissioning team in the implementation of the commissioning process. If deemed necessary, this role may be appointed to an individual within the Departmental Representative's organization, a third party company, or other specialist firm.

.2 Prime Contractor's Commissioning Manager (CxMgr) – an individual appointed by the prime contractor to manage the daily commissioning activities occurring within the general contract. Typically, this role is merged in with the Prime contractor's site supervisor, with common activities delegated to the mechanical commissioning agent.

.3 Contractor's Commissioning Agent (CxAg) – a specialist retained by the mechanical contractor to execute mechanical commissioning activities. Respectively, an electrical commissioning agent may be retained depending on the electrical project requirements.

.4 Commissioning Team – the group responsible for planning, implementing and executing the commissioning activities throughout the project phases. The commissioning team will typically include the Commissioning Authority, Commissioning Agents, Commissioning Manager, sub-contractors, equipment suppliers, O&M personnel, and Departmental Representative.

1.4 GENERAL

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

.1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.

.2 Ensure appropriate documentation is compiled into the OMM.

.3 Effectively train O M staff.

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

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be operated interactively with each other as intended in accordance with Contract Documents and design criteria.

.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

.3 Design Criteria: as per client's requirements or determined by the project drawings and specifications, to meet the Project functional and operational requirements.

.4 Commissioning Manager and Commissioning Agent(s) shall coordinate their commissioning activities to avoid redundancy and inefficiencies.

.5 Commissioning Manager (prime contractor) shall be the main point of contact for daily management of all commissioning activities, and shall be responsible for ensuring all activities and deliverables are collected and submitted to the Commissioning Authority as described herein.

1.5 COMMISSIONING OVERVIEW

.1 In accordance with Section 01 91 31 Commissioning Plan.

.2 For Cx responsibilities refer to Section 01 91 31 Commissioning Plan.

.3 Cx to be a line item of Contractor's cost breakdown.

.4 Cx activities supplement field quality and testing procedures described in relevant technical sections.

.5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built systems are constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.

.6 Commissioning Authority will issue the recommended Interim Acceptance letter when:

.1 Completed Cx documentation has been received, reviewed for suitability.

.2 Equipment, components, and systems have been commissioned.

.3 O M training has been completed.

1.6 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

.1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the non-functional system, including related systems as deemed required by the Commissioning Authority, to ensure effective performance.

.2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by the

Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.7 PRE-CX REVIEW

.1 Before Construction:

.1 Review contract documents, confirm by writing to the Commissioning Authority.

.1 Adequacy of provisions for Cx.

.2 Aspects of design and installation pertinent to success of Cx.

.2 During Construction:

.1 Co-ordinate provision, location, and installation of provisions for Cx.

.3 Before start of Cx:

.1 Have completed Cx Plan up-to-date.

.2 Ensure installation of related components, equipment, sub-systems, and systems are complete.

.3 Fully understand Cx requirements and procedures.

.4 Have Cx documentation shelf-ready.

.5 Understand completely design criteria and intent and special features.

.6 Submit complete start-up documentation to the Commissioning Authority.

.7 Have Cx schedules up-to-date.

.8 Ensure systems have been cleaned thoroughly.

.9 Complete TAB procedures on systems, submit TAB reports to Commissioning Authority for review and recommended approval.

.10 Ensure "As-Built" system schematics are available.

.4 Inform Commissioning Authority in writing of discrepancies and deficiencies on finished works.

1.8 CONFLICTS

.1 Report conflicts between requirements of this section and other sections to Commissioning Authority before start-up and obtain clarification.

.2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.9 ACTION AND INFORMATIONAL SUBMITTALS

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

.1 Submit no later than [2] weeks after award of Contract:

.1 Name of Contractor's Cx Agent.

.2 Draft Commissioning Plan.

.3 Preliminary Commissioning schedule.

.2 Request in writing to Commissioning Authority for changes to submittals and obtain written approval at least [2] weeks prior to start of Cx.

.3 Submit proposed Cx procedures to Commissioning Authority and obtain recommended approval at least [2] weeks prior to start of Cx.

.4 Provide supplemental support documentation relating to the Cx process as required by Commissioning Authority.

1.10 COMMISSIONING DOCUMENTATION

.1 Refer to Section 01 91 33 Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and instructions for use. Contractor's Cx Agent shall submit their proposed Cx Forms for review by the Cx Authority, prior to implementation.

.2 Commissioning Authority to review and recommend approval of Cx documentation.

.3 Provide completed and reviewed Cx documentation to Commissioning Authority.

1.11 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule.

.2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:

.1 Review and approval of Cx reports.

.2 Verification of reported results.

.3 Repairs, retesting, re-commissioning, re-verification.

.4 Training (Systems demonstrations).

1.12 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings. Minimum of [5] Cx meetings: Kickoff (60%), 75% progress, 90% progress, 100% progress and final.

.2 Purpose: to identify and resolve issues, monitor progress, identify deficiencies, relating to Cx.

.3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.

.4 At 60% construction completion stage, Cx Manager and/or Cx Agent to call a Cx kickoff meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:

.1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.

.2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.

.5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.

.6 Meetings will be chaired by the Cx Manager and/or the Cx Agent, who will record and distribute minutes.

.7 Ensure subcontractors and relevant manufacturer representatives are present at kickoff (60%) and subsequent Cx meetings and as required.

1.13 STARTING AND TESTING

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

1.14 WITNESSING OF STARTING AND TESTING

.1 Provide two (2) weeks notice prior to commencement to allow adequate presence of relevant witnesses.

.2 Commissioning Authority may need to witness start-up and testing.

.3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers, and equipment manufacturers.

1.15 MANUFACTURER'S INVOLVEMENT

.1 Factory testing: manufacturer to:

.1 Coordinate time and location of testing.

.2 Provide testing documentation for review and recommended approval by Commissioning Authority.

.3 Arrange for Commissioning Authority to witness tests.

.4 Obtain written review of test results and documentation from Commissioning Authority before delivery to site.

.2 Obtain manufacturer’s installation, start-up, and operations instructions prior to start-up of components, equipment and systems and submit for review to the Commissioning Authority

.1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.

.2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.3 Integrity of warranties:

.1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.

.2 Verify with manufacturer that testing as specified will not void warranties.

.4 Qualifications of manufacturer's personnel:

.1 Experienced in design, installation and operation of equipment and systems.

.2 Ability to interpret test results accurately.

.3 To report results in clear, concise, logical manner.

1.16 PROCEDURES

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.

.2 Conduct start-up and testing in following distinct phases:

.1 Included in delivery and installation:

.1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.

.2 Visual inspection of quality of installation.

.2 Start-up: follow accepted start-up procedures.

.3 Operational testing: document equipment performance.

.4 System PV: include repetition of tests after correcting deficiencies.

.5 Post-substantial performance verification: to include fine-tuning.

.3 Correct deficiencies and obtain recommended approval from Commissioning Authority after distinct phases have been completed and before commencing next phase.

.4 Document the required tests on approved PV forms.

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by the Commissioning Authority. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

.1 Minor equipment/systems: implement corrective measures recommended by the Commissioning Authority.

.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures recommended by the Commissioning Authority.

.3 If evaluation report concludes that major damage has occurred, Commissioning Authority shall reject equipment use.

.1 Rejected equipment to be removed from site and replace with new.

.2 Subject new equipment/systems to specified start-up procedures.

1.17 START-UP DOCUMENTATION

.1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.

.2 Start-up documentation to include:

.1 Factory and on-site test certificates for specified equipment.

.2 Pre-start-up inspection reports.

.3 Signed installation/start-up check lists.

.4 Start-up reports,

.5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

1.18 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

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

.2 With assistance of manufacturer develop written maintenance program and submit to Commissioning Authority for review before implementation.

.3 Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.19 TEST RESULTS

.1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.

.2 Provide manpower and materials, assume costs for re-commissioning.

1.20 START OF COMMISSIONING

.1 Notify Commissioning Authority at least two (2) weeks prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.21 INSTRUMENTS / EQUIPMENT

.1 Submit to Cx Authority for review and recommended approval:

.1 Complete list of instruments proposed to be used.

.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.

.2 Provide the following equipment as required:

.1 2-way radios.

.2 Ladders.

.3 Equipment as required to complete work.

1.22 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:

.1 Under actual and/or simulated operating conditions, over entire operating range, in all modes.

.2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturer's operating instructions.

.4 EMCS trending to be available as supporting documentation for performance verification.

1.23 WITNESSING COMMISSIONING

.1 Departmental Representative and/or Commissioning Authority to witness activities and verify results.

1.24 AUTHORITIES HAVING JURISDICTION

.1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of Authority Having Jurisdiction, arrange for AHJ to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.

.2 Obtain certificates of approval, acceptance and compliance with rules and regulation of Authority Having Jurisdiction. Provide copies to Commissioning Authority within one (1) week of test and with Cx report.

1.25 COMMISSIONING CONSTRAINTS

.1 Since access into secure or sensitive areas will be very difficult after occupancy, it is necessary to complete Cx of occupancy, weather, secure, and seasonal sensitive equipment, and systems before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.26 EXTRAPOLATION OF RESULTS

.1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when reviewed by Commissioning Authority in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.

1.27 EXTENT OF VERIFICATION

.1 Provide manpower and instrumentation to verify up to 75% of reported results, unless specified otherwise in other sections.

.2 Number and location to be at discretion of the Commissioning Authority.

.3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.

.4 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.

.5 Perform additional commissioning until results are acceptable to the Commissioning Authority.

1.28 REPEAT VERIFICATIONS

.1 Assume costs incurred by Commissioning Authority for third and subsequent verifications where:

.1 Verification of reported results that fail to receive the Cx Authority recommended approval.

.2 Repetition of second verification again fails to receive recommended approval.

.3 Commissioning Authority deems Contractor's request for second verification was premature.

1.29 SUNDRY CHECKS AND ADJUSTMENTS

.1 Make adjustments and changes which become apparent as Cx proceeds.

.2 Perform static and operational checks as applicable and as required.

1.30 DEFICIENCIES, FAULTS, DEFECTS

.1 Correct deficiencies found during start-up and Cx to satisfaction of the Commissioning Authority.

.2 Report problems, faults or defects affecting Cx to the Commissioning Authority in writing. Stop Cx until problems are rectified. Proceed with recommended approval from the Commissioning Authority.

1.31 COMPLETION OF COMMISSIONING

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

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

.3 Cx to be considered complete when contract Cx deliverables have been submitted and reviewed by the Commissioning Authority.

1.32 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.33 TRAINING / SYSTEMS DEMONSTRATION

.1 In accordance with Section 01 91 41 Commissioning Training.

1.34 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.35 OCCUPANCY

.1 Cooperate fully with Departmental Representative, and Commissioning Authority during stages of acceptance and occupancy of facility.

1.36 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and PV if:

.1 Accuracy complies with these specifications.

.2 Calibration certificates have been deposited with the Commissioning Authority.

.2 Calibrated building control sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.37 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances:

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

.2 Instrument accuracy tolerances:

.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

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

1.38 PERFORMANCE TESTING

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

Part 2 Products

.1 Commissioning documentation (plan, schedule, reports).

Part 3 Execution

.1 Perform commissioning tasks during construction phase and warranty phase.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

.2 Related Requirements

.1 Section 01 91 13 – Commissioning Requirements

.2 Section 01 91 33 – Commissioning Forms

.3 Section 01 91 41 – Commissioning Training

.4 Section 23 08 00 – Mechanical Commissioning

.5 Section 23 08 01 – Performance Verification

.6 Section 26 05 00 – Common Work Results for Electrical

1.2 REFERENCES

.1 CSA Standard Z320 -2011 Building Commissioning

.2 ASHRAE Standard 202-2013 Commissioning Process for Buildings and Systems

1.3 GENERAL

.1 Provide a fully functional mechanical and electrical system:

.1 Systems, equipment, and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.

.2 Departmental Representative and O&M personnel have been fully trained in aspects of installed systems.

.3 Optimized life cycle costs.

.4 Complete documentation relating to installed equipment and systems.

.2 Term "Cx" in this section means "Commissioning".

.3 Use this Cx Plan as master planning document for Cx:

.1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.

.2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.

.3 Sets out deliverables relating to O&M, process, and administration of Cx.

.4 Describes process of verification of how built works meets the project requirements.

.5 Produces a complete functional system prior to issuance of Certificate of Occupancy.

.6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:

.1 Overview of Cx.

.2 General description of elements that make up Cx Plan.

.3 Process and methodology for successful Cx.

.4 Acronyms:

.1 Cx - Commissioning

.2 CxA – Commissioning Authority

.3 CxAg – Commissioning Agent (Contractor)

.4 EMCS - Energy Monitoring and Control Systems.

.5 O M – Operating and Maintenance (staff)

.6 OMM - Operation and Maintenance Manuals

.7 PI - Product Information.

.8 PV - Performance Verification.

.9 TAB - Testing, Adjusting and Balancing.

.10 WHMIS - Workplace Hazardous Materials Information System.

.5 Commissioning terms used in this Section:

.1 Bumping: short term start-up to prove ability to start and prove correct rotation.

.2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

.1 Cx Plan to be 95% completed before the start of commissioning in the construction phase.

.2 Cx Plan to be 100% completed [2] weeks prior to the start of commissioning activities, take into account:

.1 Approved shop drawings and product data.

.2 Approved changes to contract.

.3 Contractor's project schedule.

.4 Cx schedule.

.5 Requirements of Contractor, sub-contractor, suppliers.

.6 Project construction team's and Cx team's requirements.

.3 Submit completed Cx Plan to Commissioning Authority, obtain written review and recommended approval.

1.5 REFINEMENT OF CX PLAN

.1 During construction phase, revise, refine and update Cx Plan (as needed) to include:

.1 Changes resulting from Client program modifications.

.2 Approved design and construction changes.

.2 Revise, refine and update as needed during the construction phase. At each revision, indicate revision number and date.

.3 Submit each revised Cx Plan to Commissioning Authority for review and obtain written approval.

.4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES, AND RESPONSIBILITIES OF CX TEAM

.1 Departmental Representative to maintain overall responsibility for the project, and communicates directly with the Commissioning Authority and Commissioning Manager.

.2 Commissioning Authority shall report to the Departmental Representative and reviews all commissioning activities and deliverables prior to project handover.

.3 Commissioning Manager (prime contractor) is main point of contact between members of commissioning team, and manages the daily commissioning activities that may occur. Cx Manager shall collect Cx documentation from Cx Agents, and submit to the Commissioning Authority for review.

.4 Commissioning Agent (mechanical) executes the mechanical specific Cx activities. Electrical trade may retain an electrical Cx Agent as needed. Cx Agent reports to the Cx Manager, and/or may report directly to the Cx Authority.

.5 Project Manager will select Cx Team consisting of following members:

.1 PWGSC Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.

.2 PWGSC Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:

.1 Review of Cx documentation from operational perspective.

.2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.

.3 Protection of health, safety and comfort of occupants and O M personnel.

.4 Monitoring of Cx activities, training, development of Cx documentation.

.5 Work closely with members of Cx Team.

.3 Commissioning Authority is responsible for:

.1 Overseeing and reviewing Cx.

.2 Monitoring Cx activities.

.3 Witnessing, verifying accuracy of reported results.

.4 Witnessing and verifying TAB and other tests.

.5 Reviewing OMM

.6 Reviewing and ensuring implementation of final Cx Plan.

.7 Reviewing performance verification results of installed systems and equipment

.8 Reviewing implementation of Training Plan.

.4 Construction Team: prime contractor, contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:

.1 Testing.

.2 TAB.

.3 Performance of Cx activities.

.4 Delivery of training and Cx documentation.

.5 Assigning Commissioning Manager as point of contact with Commissioning Authority, Departmental Representative, and PWGSC Cx Manager for administrative and coordination purposes.

.5 Contractor's Cx agent executes specified Cx activities including:

.1 Demonstrations.

.2 Training.

.3 Testing.

.4 Preparation, submission of test reports.

.6 Departmental Representative and/or O&M Manager: represents lead role in Operation Phase and onwards and is responsible for:

.1 Receiving facility.

.2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

.1 Employ the following Cx participants to verify performance of equipment and systems:

.1 Installation contractor/subcontractor:

.1 Equipment and systems except as noted.

.2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.

.1 To include performance verification.

.3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.

.4 Specialist Cx agency:

.1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.

.5 Client: responsible for intrusion and access security systems.

.6 Ensure that Cx participant:

.1 Could complete work within scheduled time frame.

.2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O M personnel, including:

.1 Modify ventilation rates to meet changes in off-gassing.

.2 Changes to heating or cooling loads beyond scope of EMCS.

.3 Changes to EMCS control strategies beyond level of training provided to O M personnel.

.4 Redistribution of electrical services.

.5 Modifications of fire alarm systems.

.6 Modifications to voice communications systems.

.7 Provide names of participants to the Commissioning Authority and details of instruments and procedures to be followed for Cx [2] weeks prior to starting date of Cx for review and recommended approval.

1.8 RISK ASSESSMENT

.1 Not used.

1.9 EXTENT OF CX

.1 Cx Structural and Architectural Systems:

.1 Not applicable.

.2 Commission mechanical systems and associated equipment:

.1 Plumbing systems:

.1 Condensate Drainage and Condensate Pumps

.2 HVAC systems:

.1 Air Handling Units

.2 Heat Recovery Ventilators

.3 Fans

.4 Split Air Conditioning Systems

.5 HVAC Controls and Graphics

.3 Noise and vibration control systems for mechanical systems.

.1 Air Handling Units

.2 Heat Recovery Ventilators

.3 Fans

.4 Split Air Conditioning Systems

.5 Condensate pumps

.4 Seismic restraint and control measures.

.1 Rooftop mounted equipment

.2 Ceiling and wall mounted mechanical equipment

.3 Commission electrical systems and equipment:

.1 Low voltage below 750 V:

.1 Low voltage equipment.

.2 Low voltage distribution systems.

.3 Fire alarm shutdown of AHUs.

1.10 DELIVERABLES RELATING TO O M PERSPECTIVES

.1 General requirements:

.1 Compile English documentation.

.2 Documentation to be computer-compatible format ready for inputting for data management.

.2 Provide deliverables:

.1 Warranties.

.2 Project record documentation.

.3 Inventory of spare parts, special tools, and maintenance materials.

.4 WHMIS information.

.5 MSDS data sheets.

.6 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.11 DELIVERABLES RELATING TO THE CX PROCESS

.1 General:

.1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.

.2 Definitions:

.1 Cx as used in this section includes:

.1 Cx of components, equipment, systems, subsystems, and integrated systems.

.2 Factory inspections and performance verification tests.

.3 Deliverables: provide:

.1 Start-up, pre-Cx activities and documentation for systems, and equipment.

.2 Completed installation checklists.

.3 Completed product information (PI) report forms.

.4 Completed performance verification (PV) report forms.

.5 Results of Performance Verification Tests and Inspections.

.6 Description of Cx activities and documentation.

.7 Description of Cx of integrated systems and documentation.

.8 Tests witnessed by Commissioning Authority and/or PWGSC Design Quality Review Team:

.9 Tests performed.

.10 Training (Systems Demonstrations) Plans.

.11 Cx Reports.

.12 Prescribed activities during warranty period.

.4 Contractor's Commissioning Agent to witness and review tests and reports of results prior to providing to Cx Mgr and Cx Authority.

1.12 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Items listed in this Cx Plan include the following:

.1 Pre-Start-Up inspections: by Cx Agent prior to permission to start-up and rectification of deficiencies to Commissioning Authority's satisfaction.

.2 Cx Agent to use approved check lists.

.3 Cx Agent will monitor and/or perform all these pre-start-up inspections.

.4 Include completed documentation with Cx report.

.5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed by Cx Authority and does not form part of Cx specifications.

.6 Departmental Representative will monitor some of these inspections and tests.

.7 Include completed documentation in Cx report.

.2 Pre-Cx activities - ARCHITECTURAL AND STRUCTURAL:

.1 Not applicable.

.3 Pre-Cx activities - MECHANICAL:

.1 HVAC equipment and systems:

.1 "Bump" each item of equipment in its "stand-alone" mode.

.2 At this time, complete pre-start-up checks and complete relevant documentation.

.3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

.4 Perform TAB on systems. TAB reports to be reviewed by the contractor's Cx Agent prior to submitting to the Cx Manager and Cx Authority.

.2 EMCS:

.1 EMCS trending to be available as supporting documentation for performance verification.

.2 Perform point-by-point testing in parallel with start-up.

.3 Carry out point-by-point verification.

.4 Demonstrate performance of systems, to be witnessed by the Commissioning Authority prior to start of [30] day Final Acceptance Test period.

.5 Perform final Cx and operational tests during demonstration period and [30] day test period.

.6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".

.4 Pre-Cx activities - ELECTRICAL:

.1 Low voltage distribution systems under 750 V:

.1 Requires independent testing agency to perform pre-energization and post-energization tests.

.2 Fire alarm wiring and integration

1.13 START-UP

.1 Start up components, equipment, and systems.

.2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:

.1 Air Handling Units

.2 Fans and HRV

.3 Split Air Conditioning Systems

.3 Commissioning Agent to monitor some of these start-up activities.

.1 Rectify start-up deficiencies to satisfaction of Commissioning Authority.

.4 Performance Verification (PV):

.1 Contractor's Cx Agent to perform.

.1 Repeat when necessary until results are acceptable to Commissioning Authority.

.2 Contractor's Cx Agent to use procedures modified from generic procedures to suit project requirements.

.3 Contractor's Cx Agent to witness and review reported results using approved PI and PV forms.

.4 Contractor's Cx Agent to review completed PV reports and provide to Cx Mgr and Cx Authority.

.5 Commissioning Authority reserves right to verify up to 50% of reported results at random.

.6 Failure of randomly selected item shall result in rejection of PV report or report of system start up and testing.

1.14 CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Perform Cx by specified Cx agency using procedures developed by the Commissioning Authority or alternate procedures proposed by the Contractor's commissioning agent and reviewed by the Cx Authority prior to commencement.

.2 Commissioning Manager to monitor daily Cx activities.

.3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

.4 Contractor's Commissioning Agent to witness, review reported results of, Cx activities and forward to Cx Manager and Cx Authority for recommended approval.

.5 Commissioning Authority reserves the right to verify up to 50% percent of reported results at no cost to contract.

1.15 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

.1 Perform Cx by specified Cx agency using procedures developed by the Commissioning Authority and/or alternate procedures proposed by the Contractor's commissioning agent and reviewed by the Cx Authority prior to commencement.

.2 Tests to be witnessed by the Cx Authority and documented on approved report forms by the Cx Agent.

.3 Upon satisfactory completion, Cx agent to prepare Cx Report, to be reviewed by the Commissioning Authority for recommended approval.

.4 Commissioning Authority reserves the right to verify up to 50% percent of reported results at no cost to contract.

.5 Integrated systems to include:

.1 Air Handling Units fire alarm integration

.2 Air Handling Units controls and monitoring

.3 Fan controls and monitoring

.6 Identification:

.1 In later stages of Cx, before hand-over and acceptance Contractor's commissioning agent to co-operate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, and main systems.

1.16 INSTALLATION CHECK LISTS (ICL)

.1 In accordance with Section 01 91 33 Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.17 PRODUCT INFORMATION (PI) REPORT FORMS

.1 In accordance with Section 01 91 33 Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.18 PERFORMANCE VERIFICATION (PV) REPORT

.1 In accordance with Section 01 91 33 Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.19 DELIVERABLES RELATING TO ADMINISTRATION OF CX

.1 General:

.1 Because of risk assessment, complete Cx of occupancy, weather, security, and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.20 CX SCHEDULES

.1 Cx Manager and Cx agent to prepare detailed Cx Schedule and submit to Commissioning Authority for review at the same time as project Construction Schedule. Include:

.1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems, and integrated systems, including:

.1 Design criteria, design intents.

.2 Pre-TAB review: within [2] weeks after award of contract, before construction starts.

.3 Cx agents' credentials: within [2] weeks after award of contract.

.4 Cx procedures: within [2] weeks after award of contract.

.5 Cx Report format: within [2] weeks after award of contract.

.6 Discussion of heating/cooling loads for Cx: within [2] weeks after award of contract.

.7 Submission of list of instrumentation with relevant certificates: [3] weeks before start of Cx.

.8 Notification of intention to start TAB: [3] weeks before start of TAB.

.9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.

.10 Notification of intention to start Cx: [2] weeks before start of Cx.

.11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed [1] week before start of integrated system Cx.

.12 Identification of deferred Cx.

.13 Implementation of training plans.

.14 Cx of control systems: after Cx of related systems is completed and [2] weeks before proposed date of Cx these systems.

.15 Cx reports: within [1] week upon successful completion of Cx.

.2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Departmental Representative.

.3 Within [10] months in Cx schedule for verification of performance in all seasons and wear conditions.

.2 Upon review of Cx activities, incorporate Cx Schedule into Construction Schedule.

.3 Prime Contractor, Contractor's Cx agent, and Commissioning Authority will monitor progress of Cx against this schedule.

1.21 CX REPORTS

.1 Cx Manager shall submit reports of tests, reported by the Cx Agent, to the Cx Authority who will review and verify reported results.

.2 Include completed and certified PV reports in properly formatted Cx Reports.

.3 Before reports are accepted, reported results to be subject to verification by the Commissioning Authority.

1.22 ACTIVITIES DURING WARRANTY PERIOD

.1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:

.1 Fine tuning of HVAC systems.

.2 Deferred seasonal testing.

.3 Deferred testing due to security and access restrictions.

1.23 TESTS TO BE PERFORMED BY USER

.1 None is anticipated on this project.

1.24 TRAINING PLANS

.1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.

1.25 FINAL SETTINGS

.1 Upon completion of Cx to satisfaction of Commissioning Authority lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 DOCUMENTATION

.1 Commissioning documentation (draft commissioning plan, updated commissioning plan).

Part 3 Execution

3.1 SCHEDULE

.1 Submit commissioning plan during construction phase, and update accordingly.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Commissioning forms to be completed for equipment, system, and integrated system.

.2 Related Requirements

.1 Section 01 91 13 Commissioning Requirements

.2 Section 01 91 31 Commissioning Plan

.3 Section 01 91 41 Commissioning Training

.4 Section 23 08 00 Mechanical Commissioning

.5 Section 23 08 01 Performance Verification

.6 Section 26 05 00 Common Work Results for Electrical

1.2 INSTALLATION/START-UP CHECK LISTS

.1 Include the following data:

.1 Product manufacturer's installation instructions and recommended checks.

.2 Special procedures as specified in relevant technical sections.

.3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.

.2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Commissioning Authority supplemental additional data lists will be required for specific project conditions.

.3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.

.4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Commissioning Authority. Check lists will be required during Commissioning and will be included in the Operations & Maintenance Manual (OMM) at completion of project.

.5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

.1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to

prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the OMM at completion of work.

.2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Commissioning Authority recommended approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

.1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.

.2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

.3 Prior to PV of integrated system, complete PV forms of related systems and obtain Departmental Representative's approval.

1.5 SAMPLES OF COMMISSIONING FORMS

.1 Commissioning Agent shall submit proposed PV forms to Cx Authority for review prior to implementation.

.2 Revise items on Commissioning forms to suit project requirements.

1.6 COMMISSIONING FORMS

.1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.

.2 Strategy for Use:

.1 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.

.2 Confirm operation as per design criteria and intent.

.3 Identify variances between design and operation and reasons for variances.

.4 Verify operation in specified normal and emergency modes and under specified load conditions.

.5 Record analytical and substantiating data.

.6 Verify reported results.

.7 Form to bear signatures of recording technician and reviewed and signed off by Cx Agent.

.8 Submit immediately after tests are performed.

.9 Reported results in true measured SI unit values.

.10 Provide Commissioning Authority with originals of completed forms.

.11 Maintain copy on site during start-up, testing and commissioning period.

.12 Forms to be both hard copy and electronic format with typed written results for insertion into the OMM (Operations & Maintenance Manuals).

1.7 LANGUAGE

.1 English.

Part 2 Products

2.1 DOCUMENTATION

.1 Commissioning documentation (checklists, sign-off forms)

Part 3 Execution

3.1 SCHEDULE

.1 Perform commissioning tasks during construction phase and warranty phase.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 This Section specifies roles and responsibilities of Commissioning Training.

.2 Related Requirements

.1 Section 01 91 13 – Commissioning Requirements

.2 Section 01 91 31 – Commissioning Plan

.3 Section 01 91 33 – Commissioning Forms

.4 Section 23 08 00 – Mechanical Commissioning

.5 Section 26 05 00 – Common Work Results for Electrical

1.2 DESCRIPTION

.1 Demonstrate scheduled operation and maintenance of equipment and systems to Departmental Representative and maintenance personnel two weeks prior to date of interim completion.

.2 Departmental Representative will provide list of CSC personnel to Contractor and coordinate dates and times.

1.3 EXECUTION

.1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location. All operational modes shall be demonstrated.

.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.

1.4 TRAINEES

.1 Trainees: personnel selected for operating and maintaining this facility. Includes building operators, maintenance staff, security staff, and technical specialists as required.

.2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.5 INSTRUCTORS

.1 Cx Manager and/or Cx Agent will provide:

.1 Descriptions of systems.

.2 Instruction on design philosophy, design criteria, and design intent.

.2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:

.1 Start-Up, operation, shut-down of equipment, components, and systems.

.2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.

.3 Instructions on servicing, maintenance and adjustment of systems, equipment, and components.

.3 Contractor and equipment manufacturer to provide instruction on:

.1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.6 TRAINING OBJECTIVES

.1 Training to be detailed and concise in duration to ensure:

.1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.

.2 Effective on-going inspection, measurements of system performance.

.3 Proper preventive maintenance, diagnosis and trouble-shooting.

.4 Ability to update documentation.

.5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.7 CONDITIONS FOR DEMONSTRATIONS

.1 Equipment has been inspected and put into operation.

.2 Testing, adjusting, and balancing has been performed and equipment and systems are fully operational.

1.8 TRAINING MATERIALS

.1 Instructors to be responsible for content and quality.

.2 Provide training agenda and schedule.

.3 Training materials to include:

.1 "As-Built" Contract Documents.

.2 Operating Manual.

.3 Operating & Maintenance Manual.

.4 TAB and PV Reports.

.4 Departmental Representative and/or Cx Authority will review training materials.

.5 Training materials to be in a format that permits future training procedures of same degree of detail to be added.

.6 Training session shall include a group walkthrough of the renovation area.

.7 Supplement training materials:

.1 Multimedia presentations (PowerPoint, PDF)

.2 Manufacturer's training videos.

1.9 SCHEDULING

.1 Commissioning Schedule shall include training time.

.2 Deliver training during regular working hours, training sessions to be [4] hours in length.

.3 Training to be completed prior to acceptance of facility.

1.10 RESPONSIBILITIES

.1 Be responsible for:

.1 Implementation of training activities,

.2 Coordination among instructors,

.3 Quality of training and development of training materials,

.2 Departmental Representative and/or Commissioning Authority will evaluate training and materials.

.3 Upon completion of training, provide written report, signed by Instructors, witnessed by Departmental Representative, and/or Commissioning Authority.

1.11 TRAINING CONTENT

.1 Training to include demonstrations by Instructors using the installed equipment and systems.

.2 Content includes:

.1 Review of facility and occupancy profile.

.2 Functional requirements.

.3 System philosophy, limitations of systems and emergency procedures.

.4 Review of system layout, equipment, components, and controls.

.5 Equipment and system start-up, operation, monitoring, servicing, maintenance, and shut-down procedures.

.6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.

.7 Maintenance and servicing.

.8 Trouble-shooting diagnosis.

.9 Interaction among systems during integrated operation.

.10 Review of O M documentation.

.3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

Part 2 Products

2.1 DOCUMENTATION

.1 Training materials and documentation (as applicable).

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

Part 3 Execution

3.1 SCHEDULING AND AGENDA

.1 Provide training agenda listing all included systems, and indicate time allocations.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Removal and or salvage of designated construction.

.2 Disposal of materials.

1.2 RELATED SECTIONS

.1 Section 01 01 50 – General Instructions (CSC)

.2 Section 01 74 19 – Waste Management and Disposal

1.3 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.

.2 National Building Code Part 8

1.4 GENERAL

.1 Submit detailed schedule for any and all work affecting the existing building. Consult with CSC regarding work required. Submit schedule minimum 10 calendar days prior to scheduled work.

.2 Comply with requirement of the Waste Management and Disposal Requirements in Section 01 74 19 – General Instructions (CSC).

1.5 SCHEDULING

.1 Submit with the project schedule a coordinated complete series of drawings, diagrams, details and supporting data clearly showing sequence of demolition and removal work, reconstruction, occupant moves required, material storage, temporary barriers for all phases of the demolition construction work.

.2 Perform noisy, malodorous, dusty, work as directed by CSC and the Departmental Representative.

1.6 SITE CONDITIONS

.1 Review the Project Specific Hazardous Building Materials Assessment for the Kent Institution with the Departmental Representative.

.1 Remove hazardous materials in a manner consistent with the Occupational Health & Safety Regulation, General Hazard Requirements of the Work Safe BC, and other applicable regulations. Changes to the Work will be dealt in accordance with the provisions of the Contract Documents.

.1 All plumbing gaskets shall be considered asbestos containing materials (ACM).

.2 Handle and dispose of all hazardous and banned materials in accordance with the Special Waste Regulation, and Regional and Municipal regulations. These hazardous and banned materials include but are not limited to asbestos, drywall (banned from disposal), Polychlorinated Biphenyls (PCBs), abandoned chemicals (gasoline, pesticides, herbicides, flammable and combustible substances), all refrigerant from cooling equipment, lead-based paints, smoke detectors, and mercury containing switches.

.2 Should material resembling spray or trowel-applied asbestos or other designated substance listed as hazardous be encountered, stop work, take preventative measures, and notify Departmental Representative immediately.

.1 Do not proceed until written instructions have been received from the Departmental Representative.

.3 Notify Departmental Representative minimum 5 working days before disrupting building access or services.

.4 The Contractor shall accept the site as it exists and will be responsible for all deconstruction work as required.

1.7 DEMOLITION PROCEDURES

.1 Materials: As specified in Product sections; match existing Products and work for patching and extending work.

.2 Employ skilled and experienced installer to perform alteration work.

.3 Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.

.4 Remove, cut, and patch Work in a manner to minimize damage and to provide means of restoring Products and finishes to original condition.

.5 Refinish existing visible surfaces to remain in renovated rooms and spaces, to renewed condition for each material, with a neat transition to adjacent finishes.

.6 Where new Work abuts or aligns with existing, provide a smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

.7 When finished surfaces are cut so that a smooth transition with new Work is not possible, terminate existing surface along a straight line at a natural line of division and submit recommendation to Departmental Representative for review.

.8 Where a change of plane of 6 mm or more occurs, submit recommendation for providing a smooth transition; to Departmental Representative for review. Request instructions from the Departmental Representative.

.9 Patch or replace portions of existing surfaces which are damaged, lifted, discoloured, or showing other imperfections.

.10 Finish surfaces as specified in individual Product sections.

1.8 PROTECTION

.1 Prevent movement, settlement, or other damage to adjacent structures, utilities, and parts of building to remain in place. Provide bracing and shoring required.

.2 Keep noise, dust, and inconvenience to occupants to a minimum. Noisy work will only be permitted at times agreed to and accepted by the Departmental Representative.

.3 Protect building mechanical and electrical systems, services and equipment.

.4 Provide temporary dust screens, covers, railings, supports and other protection as required.

.5 Do not overload any portion of the structure with material or equipment

.6 Where existing load bearing partitions are to be removed, do not commence work until new support structure is installed, inspected and approved by the Departmental Representative.

.7 Cease operations and notify the Departmental Representative if safety of any adjacent work or structure appears to be endangered. Take all precautions to support the structure. Do not resume operations until reviewed with the Departmental Representative.

.8 Ensure safe passage of building occupants around area of demolition. Remove debris and clean areas of access immediately.

.9 Conduct demolition to minimize interference with adjacent and occupied building areas.

1.9 QUALITY ASSURANCE

.1 Salvage or Demolition Firm: Company (ies) must be experienced and specializing in performing the work of this section with documented experience in similar types of deconstruction work.

.2 Qualifications of Workers: Provide a supervisor who shall be present at all times during the deconstruction work and who shall be thoroughly familiar with the work required and who shall direct all work. Provide one person on site who is responsible for maintaining the safety barriers and protection of the workers and the public.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 PREPARATION

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

.2 Provide, erect, and maintain temporary barriers security partitions at locations indicated agreed to with CSC and the Departmental Representative.

.1 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued occupancy. Refer to complete project drawings. The extent of the partitions required may exceed the information shown on the demolition drawings.

.3 Erect and maintain weatherproof closures for exterior openings.

.4 Protect existing materials which are not to be demolished.

.5 Prevent movement of structure; provide bracing and shoring.

3.2 PROTECTION

.1 Maintain public safety and traffic control precautions at all times during the demolition work, using properly trained qualified persons to control all Contractor's activities, vehicles, equipment, traffic and all public pedestrian and vehicles traffic that are coming to and from the site or passing along the vicinity of the site access locations.

.2 Prevent movement, settlement, or damage to adjacent structures, utilities, and parts of building to remain in place. Provide bracing and shoring required.

.3 Keep noise, dust, and inconvenience to occupants to minimum.

.4 Protect building systems, services and equipment.

.5 Do Work in accordance with Section 01 35 33 - Health and Safety.

3.3 SITE REMOVALS

.1 Remove items as indicated.

3.4 DEMOLITION

.1 The electrical, BSCS, or mechanical services MUST NOT be terminated within the building at any time. Notify the building Departmental Representative of any requirements for partial termination of services in accordance with Division 1 requirements. Keep down time at a minimum.

.2 Remove parts of existing building to permit new construction. Sort materials into appropriate piles for reuse, recycling, or disposal.

.1 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.2 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.3 Remove temporary Work.

3.5 DISPOSAL

.1 Dispose of removed materials, to appropriate recycling facilities except where specified otherwise, in accordance with authority having jurisdiction.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 35 33 – Health and Safety Requirements

.3 Section 01 74 19 – Waste Management and Disposal

.4 Section 01 74 11 – Cleaning and Special Cleaning Procedures

1.2 REFERENCES

.1 Reports:

.1 Hazardous Building Materials Assessment, POD2 Building Boiler and Mechanical Rooms, Kent Institution, Agassiz, BC, by SNC-Lavalin Inc., dated January 22, 2018 (further referred to herein as the Assessment Report). The Assessment Report is attached in the Appendix of the Project Specifications.

.2 Definitions:

.1 Dangerous Goods: product, substance, or organism specifically listed or meets hazard criteria established in Transportation of Dangerous Goods Regulations.

.2 Hazardous Material: product, substance, or organism used for its original purpose; and is either dangerous goods or material that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when released into the environment.

.3 Hazardous Waste: hazardous material no longer used for its original purpose and that is intended for recycling, treatment or disposal.

.4 Hazardous Building Material: component of a building or structure that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when altered, disturbed or removed during maintenance, renovation or demolition.

.3 Reference Standards:

.1 Canadian Environmental Protection Act,1999 (CEPA 1999)

.1 Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149).

.2 Department of Justice Canada

.1 Transportation of Dangerous Goods Act, 1992 (TDG Act) [1992], (c. 34).

.2 Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286).

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

.1 Material Safety Data Sheets (MSDS).

.4 National Research Council Canada Institute for Research in Construction (NRC-IRC)

.1 National Fire Code of Canada (2010).

.5 WorkSafeBC

.1 British Columbia's Occupational Health and Safety Regulation (BC Reg. 296/97, including amendments to date of work)

.2 "Safe Work Practices for Handling Asbestos" (2017)

.3 "Safe Work Practices for Handling Lead" (2017)

.6 British Columbia Hazardous Waste Regulation (BC Reg. 63/88, including amendments to date of work)

.7 The Federal PCB Regulations (SOR/2008-273, including amendments to date of work)

.8 Ozone-Depleting Substances and Halocarbon Alternatives Regulations (SOR/2016-137)

.9 The British Columbia Environmental Management Act - Ozone Depleting Substances and Other Halocarbons Regulation (BC Reg. 387/99, including amendments to date of work)

.10 The Federal Halocarbons Regulation (July 2003) and Regulations Amending the Federal Halocarbon Regulations, 2003 (SOR/2009-221)

.11 Surface Coating Materials Regulations (SOR/2005-109, including amendments to date of work)

.12 Canadian Construction Association

.1 Standard Construction Document CCA 82 "Mould Guidelines for the Canadian Construction Industry" (2004)

.13 The Nuclear Safety and Control Act (1997, c.9)

.1 Nuclear Substances and Radiation Devices Regulations (SOR/2000-207)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data for hazardous materials to be used by the Contractor to complete the Work:

.1 Submit manufacturer's instructions, printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 33 - Health and Safety Requirements to Departmental Representative for each hazardous material required prior to bringing hazardous material on site.

.3 Submit hazardous materials management plan to Departmental Representative that identifies hazardous materials, usage, location, personal protective equipment requirements, and disposal arrangements.

.4 Construction/Demolition Waste Management:

.1 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating percentage of construction/demolition wastes were recycled or salvaged

.5 Low-Emitting Materials: submit listing of adhesives and sealants used in building, comply with VOC and chemical component limits or restrictions requirements.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle hazardous materials to be used by the Contractor to complete the Work in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver hazardous materials to be used by the Contractor to site in original factory packaging, labelled with manufacturer's name and address.

.3 Transport hazardous materials and wastes in accordance with Transportation of Dangerous Goods Act, Transportation of Dangerous Goods Regulations, and applicable provincial regulations.

.4 Storage and Handling Requirements:

.1 Co-ordinate storage of hazardous materials to be used by the Contractor to complete the Work with Departmental Representative and abide by internal requirements for labelling and storage of materials and wastes.

.2 Store and handle hazardous materials and wastes in accordance with applicable federal and provincial laws, regulations, codes, and guidelines.

.3 Store and handle flammable and combustible materials in accordance with National Fire Code of Canada requirements.

.4 Keep no more than 45 litres of flammable and combustible liquids such as gasoline, kerosene and naphtha for ready use.

.1 Store flammable and combustible liquids in approved safety cans bearing the Underwriters' Laboratory of Canada or Factory Mutual seal of approval.

.2 Storage of quantities of flammable and combustible liquids exceeding 45 litres for work purposes requires the written approval of the Departmental Representative.

.5 Transfer of flammable and combustible liquids is prohibited within buildings.

.6 Transfer flammable and combustible liquids away from open flames or heat-producing devices.

.7 Solvents or cleaning agents must be non-flammable or have flash point above 38 degrees C.

.8 Store flammable and combustible waste liquids for disposal in approved containers located in safe, ventilated area. Keep quantities to minimum.

.9 Observe smoking regulations, smoking is prohibited in areas where hazardous materials are stored, used, or handled.

.10 Storage requirements for quantities of hazardous materials and wastes in excess of 5 kg for solids, and 5 litres for liquids:

.1 Store hazardous materials and wastes in closed and sealed containers.

.2 Label containers of hazardous materials and wastes in accordance with WHMIS.

.3 Store hazardous materials and wastes in containers compatible with that material or waste.

.4 Segregate incompatible materials and wastes.

.5 Ensure that different hazardous materials or hazardous wastes are stored in separate containers.

.6 Store hazardous materials and wastes in secure storage area with controlled access.

.7 Maintain clear egress from storage area.

.8 Store hazardous materials and wastes in location that will prevent them from spilling into environment.

.9 Have appropriate emergency spill response equipment available near storage area, including personal protective equipment.

.10 Maintain inventory of hazardous materials and wastes, including product name, quantity, and date when storage began.

.11 When hazardous waste is generated on site:

.1 Co-ordinate transportation and disposal with Departmental Representative.

.2 Comply with applicable federal, provincial and municipal laws and regulations for generators of hazardous waste.

.3 Use licensed carrier authorized by provincial authorities to accept subject material.

.4 Before shipping material obtain written notice from intended hazardous waste treatment or disposal facility it will accept material and it is licensed to accept this material.

.5 Label containers with legible, visible safety marks as prescribed by federal and provincial regulations.

.6 Only trained personnel handle, offer for transport, or transport dangerous goods.

.7 Provide photocopy of shipping documents and waste manifests to Departmental Representative.

.8 Track receipt of completed manifest from consignee after shipping dangerous goods. Provide photocopy of completed manifest to Departmental Representative.

.9 Report discharge, emission, or escape of hazardous materials immediately to Departmental Representative and appropriate provincial authority. Take reasonable measures to control release.

.12 Ensure personnel have been trained in accordance with Workplace Hazardous Materials Information System (WHMIS) requirements.

.13 Report spills or accidents immediately to Departmental Representative. Submit a written spill report to Departmental Representative within 24 hours of incident.

.5 Include provisions for Work of this Section in Waste Reduction Workplan as outlined in Section 01 74 19 – Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Description:

.1 Bring on site only quantities hazardous material required to perform Work.

.2 Maintain MSDS in proximity to where materials are being used. Communicate this location to personnel who may have contact with hazardous materials.

Part 3 Execution

3.1 HAZARDOUS MATERIALS ABATEMENT

.1 Scope of Abatement Activities.

.1 Abatement shall be conducted to handle, alter, remove and/or dispose of hazardous building materials as identified in the Assessment Report in accordance with applicable regulations, guidelines, standards and/or best practices for such work, where such identified hazardous building materials will be impacted (handled, altered, damaged, removed) by the Work.

.2 Contractor is responsible for reviewing plans, specifications and reports such that they understand the locations and amounts of hazardous materials that will be impacted by the Work of this contract, and such that appropriate plans and budgets can be included in their overall bids.

.3 The listing below is a summary of the identified hazardous building material categories and associated removal and disposal regulations, guidelines and/or standards.

.1 Asbestos-Containing Materials (ACMs)

.1 Removal, alteration and/or disposal of ACMs is not anticipated to be required during the Work.

.2 Lead and Lead-Containing Paints (LCPs)

.1 Refer to the Assessment Report for identities and locations of lead-containing materials (including LCPs) that may require disturbance during the Work.

.2 Actions that will disturb lead-containing materials (including paints and materials coated with LCPs) are to be conducted in accordance with the requirements of the current version of the WorkSafeBC publication “Safe Work Practices for Handling Lead”, keeping airborne exposure to lead dust to less than the 8-hour Occupational Exposure Limit (OEL) for lead of 0.05 milligram per cubic metre of air (mg/m^3).

.3 Although LCPs and items coated with LCPs will be disturbed and/or removed for disposal during the Work, unless deemed necessary through risk assessment or cost analysis conducted by the Contractor, comprehensive removal of LCPs from items or surfaces is not expected to be required during the Work.

.1 Refer to the provisions of the 2017 WorkSafeBC publication “Safe Work Practices for Handling Lead” for removal of LCPs from surfaces before any welding and torch-cutting, should the Contractor plan to use such methods to complete the Work.

.1 Contractor will be responsible for verification testing of surfaces where LCPs have been removed. Confirmation of acceptable results is to be provided to the Departmental Representative for review before proceeding with any welding or torch-cutting on surfaces where LCPs were present.

.4 Waste transportation to be conducted in accordance with BC Reg. 63/88 and the Federal Transportation of Dangerous Goods Regulation.

.5 Waste disposal to be conducted in accordance with BC Reg. 63/88.

.3 Polychlorinated Biphenyls (PCBs)

.1 When decommissioned, verify the PCB content of high intensity discharge lamp ballasts as per the Environment Canada publication Identification of Lamp Ballasts Containing PCBs, 1991.

.2 Should a material suspected to contain PCBs become uncovered during renovation activities (i.e., dielectric fluids, hydraulic fluids), all work in the areas that may disturb the material should be stopped. Samples of the suspect material should be submitted for laboratory analysis to determine if PCBs are present.

.3 PCB-containing items identified for removal and disposal should be handled, transported, stored and disposed of in accordance with the following:

.1 The transportation and disposal requirements of BC Reg. 63/88 .

.2 The transportation requirements of the Federal Transportation of Dangerous Goods Regulation.

.3 The Federal PCB Regulations (SOR/2008-273)

.4 Mould

.1 Removal, alteration and/or disposal of mould-impacted materials is not anticipated to be required during the Work.

.5 Mercury

.1 When mercury-containing items are removed, ensure all mercury waste is handled, stored and disposed of in accordance with the requirements the following:

.1 The transportation and disposal requirements of BC Reg. 63/88.

.2 The transportation requirements of the Federal Transportation of Dangerous Goods Regulation.

.2 Precautions should be taken if workers may potentially be exposed to mercury or mercury vapours to ensure that workers exposure levels do not exceed the occupational exposure limit of 0.025

mg/m^3 as per the BC Reg. 296/97. This can be achieved by providing respiratory and skin protection applicable to the hazard and task to be completed.

.6 Ozone-Depleting Substances (ODSs)

.1 When ODS-containing equipment (and non-ODS-containing equipment containing hydrofluorocarbons [HFCs]) is to be removed, they must be recovered, handled, recycled, stored, and/or disposed of in accordance with the requirements of the following:

.1 British Columbia Environmental Management Act—Ozone Depleting Substances and Other Halocarbons Regulation (BC Reg. 387/99 as amended by BC Reg. 317/2012).

.2 The transportation requirements of the Federal Transportation of Dangerous Goods Act and Regulations.

.3 The Federal Halocarbons Regulations.

.7 Silica

.1 When silica-containing materials are to be disturbed and/or removed (e.g., coring through concrete), ensure dust control measures are employed such that airborne silica dust concentrations do not exceed 50% of the exposure limit as stipulated by BC Reg. 296/97. This would include, but not be limited to, the following:

.1 Development of an exposure control plan

.2 Providing workers with respiratory protection

.3 Wetting the surface of the materials, use of water or dust suppressing agents to prevent dust emissions

.4 Providing workers with facilities to properly wash prior to exiting the work area.

.8 Miscellaneous Solid and/or Liquid Wastes

.1 Refer to the Assessment Report for identities and locations of solid and/or liquid waste material that may require disposal or recycling during the Work.

.2 When miscellaneous solid and/or liquid wastes are removed and disposed of or recycled, it is the responsibility of the Contractor to identify and characterize the wastes observed and dispose of or recycle appropriately.

.3 Waste transportation to be conducted in accordance with BC Reg. 63/88 and the Federal Transportation of Dangerous Goods Regulation.

.4 Waste disposal to be conducted in accordance with BC Reg. 63/88.

.9 Radioactive Sources and/or Substances

.1 Removal, alteration and/or disposal of radioactive sources and/or substances are not anticipated to be required during the Work.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 Cleaning and Special Cleaning Procedures. 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 and Special Cleaning Procedures.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Dispose of hazardous waste materials in accordance with applicable federal and provincial acts, regulations, and guidelines.

.2 Recycle hazardous wastes for which there is approved, cost effective recycling process available.

.3 Send hazardous wastes to authorized hazardous waste disposal or treatment facilities.

.4 Burning, diluting, or mixing hazardous wastes for purpose of disposal is prohibited.

.5 Disposal of hazardous materials in waterways, storm or sanitary sewers, or in municipal solid waste landfills is prohibited.

.6 Dispose of hazardous wastes in timely fashion in accordance with applicable federal and provincial regulations.

.7 Minimize generation of hazardous waste to maximum extent practicable. Take necessary precautions to avoid mixing clean and contaminated wastes.

.8 Identify and evaluate recycling and reclamation options as alternatives to land disposal, such as:

.1 Hazardous wastes recycled in manner constituting disposal.

.2 Hazardous waste burned for energy recovery.

.3 Lead-acid battery recycling.

.4 Hazardous wastes with economically recoverable precious metals.

END OF SECTION

Part 1 General

1.1 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

1.2 References

.1 CAN/CSA-A23.1-14/CAN/CSA-A23.2-14, Concrete Materials and Methods of Concrete Construction/ Test Methods and Standard Practices for Concrete.

.2 ASTM C260-01, Air Entraining admixtures for Concrete

.3 ASTM C494/C494M-05, Chemical Admixtures for Concrete

.4 ASTM D1751-04(2008) Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

.5 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction

.6 ANSI/ACI 315-99, Details and detailing of Concrete Reinforcement

.7 CSA G30.3-M1998, Cold Drawn Steel Wire for Concrete Reinforcement

.8 CSA G30.5-M1983(R1998), Welded Steel Wire Fabric for Concrete Reinforcement

.9 CSA G30.18-09, Billet Steel Bars for Concrete Reinforcement

.10 CSA W186-M90(R2007), Welding of Reinforcing Bars in Reinforced Concrete Construction

.11 CSA0121-08 (R2013), Douglas Fir Plywood

.12 CSA 0151-09 Canadian Softwood Plywood

.13 CSA S269.1-1975, Falsework for Construction Purposes

.14 CAN/CSA-S269.3-M92, Concrete Formwork

1.3 Substitutes

.1 Substitution of different size bars permitted only upon written approval of Departmental Representative.

Part 2 Products

2.1 Concrete Materials

.1 Portland cement: to CAN/CSA-A3000 and CSA A23.1.

.2 Supplementary cementing materials: to CAN/CSA-A3000.

.3 Water, fine aggregates, normal density coarse aggregates: to CAN/CSA-A23.1

.4 Air entraining admixture: to CAN/CSA-23.1

.5 Chemical admixtures: to ASTM C494M as approved by Departmental Representative.

.6 Non-shrink grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents.

.1 Compressive strength: 50MPa at 28 days.

.2 Consistency:

.1 Fluid: to ASTM C827. Time of efflux through flow cone (ASTM C939), under 30 s.

.2 Flowable: to ASTM C827. Flow table, 5 drops in 3 s, (ASTM C109, applicable portion) 125 to 145%.

.3 Plastic: to ASTM C827. Flow table, 5 drops in 3 s, (ASTM C109, applicable portions) 100 to 125%.

.4 Dry pack to manufacturer's requirements.

2.2 Formwork Materials

.1 Formwork Lumber: plywood and wood formwork materials to CAN/CSA-A23.1.

.2 Form release agent: chemically active release agents containing compounds that react with free lime in concrete resulting in water insoluble soaps.

.3 Form ties: removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25mm diameter in concrete surface.

2.3 Reinforcing Materials

.1 Reinforcing steel: billet steel, grade 400, deformed bars to CAN/CSA-G30.18, unless indicated otherwise.

.2 Welded steel wire fabric: CSA G30.5. Provide in flat sheets only.

.3 Chairs, bolsters, bar supports, spacers: adequate for strength and support of reinforcing construction conditions.

.4 Adhesive Anchors: proprietary systems, pre-mixed, self-contained system with master cartons that contain foil packs/mixer/filler tube. The system would contain epoxy consisting of resin, hardener and aggregate. Submit details to Departmental Representative for review and approval.

2.4 Concrete Mixes

.1 Proportion normal density concrete in accordance with CAN/CSA-A23.1, Alternative 1 to give the following properties:

.1 Cement: Type GU Portland cement

.2 Minimum compressive strength at 28 days, class of exposure and nominal size of coarse aggregate:

Member	minimum 28-days strength (Mpa)	maximum aggregate size (mm)	exposure class	air Content Category
Concrete Pad	25	20	N	-

.3 Slump at time and point of discharge: To CSA-A23.1 Clause 4.3.2.3. When superplasticizers are used, the slump may be increased by shall kept below the point where segregation will occur. The cost of superplasticizers shall be included in the cost of the concrete. Smaller aggregate size may be used where necessary to increase slump.

.4 Air content: To CSA-A23.1 Table 2 & 4 to suit appropriate exposure class.

.5 Chemical admixtures: following admixtures in accordance with to ASTM C494M. Admixtures shall contain no salts or acids.

.6 Concrete mix designs shall be submitted to a material specialist for approval and to Departmental representative for review prior to any concrete work.

2.5 Reinforcing Steel Fabrication

.1 Fabricate reinforcing to CAN/CSA A23.1

.2 Obtain Departmental Representative's approval for locations of reinforcement splices other than shown on steel placing drawings.

.3 Upon approval of Departmental Representative, weld reinforcement in accordance with CSA W186.

Part 3 Execution

3.1 Workmanship

.1 Obtain Departmental Representative's approval before placing concrete. Provide 48 h notice prior to placing of concrete.

.2 Pumping of concrete is permitted only after approval of equipment and mix.

.3 Ensure reinforcement and inserts are not disturbed during concrete placement

.4 Prior to placing of concrete obtain Departmental Representative's approval of proposed method for protection of concrete during placing and curing.

.5 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

.6 Do not place load upon new concrete until authorized by Departmental Representative.

.7 Anchor bolts.

.1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.

.2 With approval of Departmental Representative, grout anchor bolts in holes drilled after concrete has set. Drilled holes to be to manufacturer's recommendations.

.3 Protect anchor bolt holes from water accumulations, snow and ice build-up.

.4 Set bolts and fill holes with epoxy grout.

.5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.

3.2 Formwork Installation

.1 Verify lines, levels and wall locations before proceeding with formwork and ensure dimensions agree with drawings.

.2 Construct forms to produce finished concrete conforming to shape, dimensions, locations and levels indicated with tolerances required by CAN/CSA A23.1

.3 Re-use formwork and falsework subject to requirements of CAN/CSA-A23.1. Contractor shall be responsible for design, engineering and construction of formwork

3.3 Placing Reinforcement

.1 Place reinforcing steel to CAN/CSA A23.1

.2 Obtain Departmental Representative's approval of reinforcing steel and placing before concrete is placed.

.3 Clean reinforcing before placing concrete

.4 When field bending of reinforcement is approved by Departmental Representative, bend without heat, applying slow and steady pressure.

3.4 Finishing

.1 Equipment pads: smooth troweled surface

END OF SECTION

Part 1 General

1.1 Related Sections

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 74 19 – Waste Management and Disposal

.3 Section 09 91 13 – Exterior Painting

.4 Section 09 91 23 – Interior Painting

1.2 References

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

.1 ASTM A 36/A 36M-14, Standard Specification for Carbon Structural Steel.

.2 ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, Threaded Rod 60,000psi Tensile Strength.

.3 ASTM A325-10e1, Standard Specification for Structural Bolts, Steel, Heat Treated,120/105 ksi Minimum Tensile Strength.

.4 ASTM A 325M-13, Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength.

.5 ASTM A 108-07, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.

.2 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturer's Association (CPMA).

.1 CISC/CPMA 1-73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.

.2 CISC/CPMA 2-75, A Quick-Drying Primer for Use on Structural Steel.

.3 Canadian General Standards Board (CGSB).

.1 CGSB 85.10-99, Protective Coatings for Metals.

.4 Canadian Standards Association (CSA International)

.1 CAN/CSA-G40.20-13, General Requirements for Rolled or Welded Structural Quality Steel.

.2 CAN/CSA-G40.21-13, Structural Quality Steel.

.3 CAN/CSA-G164-M92 (withdrawn), Hot Dip Galvanizing of Irregularly Shaped Articles.

.4 CAN/CSA-S16-14, Design of steel structures.

.5 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel.

.6 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.

.7 CSA W55.3-08 (R2013), Certification of Companies for Resistance Welding of Steel and Aluminum.

.8 CSA W59-13, Welded Steel Construction (Metal Arc Welding).

.9 CSA W178.1-14, Certification of Welding Inspection Organizations.

.10 CSA W178.2-14, Certification of Welding Inspectors.

1.3 Shop Drawings

.1 Submit shop drawings including fabrication and erection documents and materials list in accordance with Section 01 33 00 - Submittal Procedures.

.2 On erection drawings, indicate all details and information necessary for assembly and erection purposes such as, description of methods, sequence of erection, type of equipment used in erection and temporary bracings.

.3 No fabrication or work shall be commenced until the review and approval of the shop drawings. The contractor shall assume full responsibility for any fabrication and work done prior to review and approval of the shop drawings.

.4 Contractor shall co-ordinate and verify all dimension and locations prior to production of the drawing.

1.4 Quality Assurance

.1 Submit 2 copies of mill test reports showing chemical and physical properties and other details of steel to be incorporated into work at least 2 weeks prior to fabrication of structural steel. Mill test reports shall be certified by metallurgists qualified to practice in British Columbia, Canada.

.2 Fabricator of structural steel shall, in addition, provide an affidavit stating that materials and products used in fabrication conform to applicable material and products standards called for by design drawings and specifications.

1.5 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 Materials

.1 Structural steel: to CAN/CSA-G40.21 Grade as indicated as following.

Hollow structural sections (HSS)	-350W, Class C
W shapes	-350W
Other structural steel and miscellaneous metal	-300W

.2 Anchor bolts: ASTM A307 unless noted otherwise on drawings.

.3 Bolts, nuts and washers: to ASTM A 325

.4 Welding materials: to CSA W48 Series and CSA W59 and certified by Canadian Welding Bureau.

.5 Shop paint primer: to CISC/CPMA 1.

.6 Hot dip galvanizing: galvanize steel, where indicated, to CAN/CSA-G164, minimum zinc coating of 610 g/m^2. Submit test certificate before installation.

2.2 Fabrication

.1 Fabricate structural steel in accordance with CAN/CSA-S16 and in accordance with reviewed shop drawings.

.2 Welding shall be performed by certified welders. Fabrication shops shall be approved by the Canadian welding bureau to CSA-W47.1 (Division 1 or 2). Certification shall be supplied to the Departmental Representative upon request.

.3 Unless noted otherwise, install all rolled steel sections with mill camber upwards.

.4 Continuously seal members by continuous welds where indicated. Grind smooth.

.5 All areas of galvanized parts shall be grounded off prior to welding. Part 2 coats minimum of zinc rich primer read mix to CAN/CGSB-1.181 after welding.

.6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

2.3 Shop Painting

.1 Clean, prepare surfaces and shop prime structural steel in accordance with CAN/CSA-S16.

.2 Clean members, remove loose mill scale, rust, oil, dirt and other foreign matter. Prepare surface according to SSPC SP7 brush off blast.

.3 Apply one coat of CISC/CMPD2-75 primer in shop to steel surfaces to achieve minimum dry film thickness of 3 to 4 mils, except:

.1 Surfaces to be encased in concrete.

.2 Surfaces to receive field installed stud shear connections.

.3 Surfaces and edges to be field welded.

.4 Faying surfaces of friction-type connections.

.5 Below grade surfaces in contact with soil.

.4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C.

.5 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.

.6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

Part 3 Execution

3.1 General

.1 Structural steel work: in accordance with CAN/CSA-S16.

.2 Welding: in accordance with CSA W59.

.3 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

3.2 Connection to Existing Work

.1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to Departmental Representative for direction before commencing fabrication.

3.3 Marking

.1 Mark materials in accordance with CAN/CSA G40.20/G40.21. Do not use die stamping. If steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection.

.2 Match marking: shop mark for fit and match.

3.4 Erection

.1 Erect structural steel, as indicated and in accordance with CAN/CSA-S16 and in accordance with reviewed erection drawings.

.2 Field cutting or altering structural members: to approval of Departmental Representative.

.3 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.

.4 Continuously seal members by continuous welds where indicated. Grind smooth.

.5 Install and torque all bolts and drilled anchors in accordance with manufacturer's specifications and procedures.

.6 Any misfit or misalignment must be reported to the Departmental Representative. The contractor shall provide proposed remedial measures to the Departmental Representative for review and approval. Any remedial work on connections must be reviewed and/or redesigned by the connection engineer. Costs of remedial work are at the expense of the contractor.

.7 Do not notch or cut openings in any of the framing members and connection without prior approval from the Departmental Representative.

.8 Provide temporary bracing to structure for stability and safety as required until the completion of the steel structure.

3.5 Field Quality Control

.1 The Departmental Representative though CWMM will provide inspection of the steel work shown on the structural drawing. The Departmental Representative though CWMM will not be responsible for inspection of the Contractor's work as described in Clause 7.12 of the CISC Code of Standard Practice for Structural Steel. The Contractor is responsible for the accuracy and completeness of his own work and shall verify that the structural steel has been fabricated, erected and finished in accordance with the contract specifications.

.2 Inspection and testing of materials and workmanship will be carried out by independent testing laboratory designated by Departmental Representative.

.3 Testing requirements are as follows:

.1 Visual Field Inspection and Bolt Torque Testing (Random 10% of Bolts) of all bolted connections.

.2 Non-Destructive Testing of Welds: 100% of all welds to be visually inspected.

.4 Welding inspector shall be certified to CSA W178.2 Level 2 or Level 3.

.5 Provide safe access and working areas for testing on site, as required by testing agency and as authorized by Departmental Representative.

.6 Submit test reports to Departmental Representative within 1 week of completion of inspection.

.7 Costs of tests shall be assigned by the Departmental Representative for independent testing.

3.6 Field Painting

.1 Paint in accordance with Section 09 91 13 – Exterior Painting and Section 09 91 23 – Interior Painting.

.2 Touch up damaged surfaces and surfaces without shop coat with primer to SSPC-SP-6 except as specified otherwise. Apply in accordance with CAN/CGSB 85.10.

END OF SECTION

Part 1 General

1.1 Related Requirements

.1 Section 07 52 00 - Modified Bituminous Membrane Roofing

1.2 References

.1 CSA International

.1 CSA B111- 1974 (R2003), Wire Nails, Spikes and Staples.

.2 CSA O121- 08, Douglas Fir Plywood.

.3 CAN/CSA-O141- 05, Softwood Lumber.

.4 CSA O151- 09, Canadian Softwood Plywood.

.5 CAN/CSA-O325.0- 07, Construction Sheathing.

.6 CAN/CSA O80-15 series, Wood Preservation.

.7 CAN/CSA O86-14, Engineering Design in Wood.

.2 Forest Stewardship Council (FSC)

.1 FSC-STD-01-001- 2004, FSC Principle and Criteria for Forest Stewardship.

.2 FSC-STD-20-002- 2004, Structure and Content of Forest Stewardship Standards V2-1.

.3 FSC Accredited Certified Bodies.

.3 Green Seal Environmental Standards (GS)

.1 GS-11- 2008, 2nd Edition, Paints and Coatings.

.4 National Lumber Grades Authority (NLGA)

.1 Standard Grading Rules for Canadian Lumber 2000.

.5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113- A2007, Architectural Coatings.

1.3 Action & Informational Submittals

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for rough carpentry work and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Wood Certification: submit vendor's Chain-of-Custody Certificate number for FSC certified wood.

.4 Low-Emitting Materials:

.1 Submit listing of composite wood products used in building, stating that they contain no added urea-formaldehyde resins, and laminate adhesives used in building, stating that they contain no urea-formaldehyde.

1.4 Quality Assurance

.1 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

.2 Plywood identification: by grade mark in accordance with applicable CSA standards.

.3 Sustainable Standards Certification:

.1 Certified Wood: submit listing of wood products and materials used in accordance with FSC-STD-01-001.

1.5 Delivery, Storage & Handling

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

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

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect wood from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 19 Waste Management and Disposal.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 Materials

.1 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% or less, SPF No.1 grade or better in accordance with following standards:

.1 CAN/CSA-O141.

.2 NLGA Standard Grading Rules for Canadian Lumber.

.3 FSC certified.

.2 Furring, blocking, nailing strips, grounds, rough bucks, curbs, fascia backing:

.1 Board sizes: "Standard" or better grade.

.2 Dimension sizes: "Standard" light framing or better grade.

.3 Post and timbers sizes: "Standard" or better grade.

.3 Pressure treatment of wood materials:

.1 All timber members shall be treated with water-borne salts:

.1 Conform to CSA O80 Series and its current amendments.

.2 Only Alkaline Copper Quat (ACQ-C, ACQ-D, ACQ-D Carbonate) and Copper Azole (CBA-A & CA-B) will be accepted.

.3 Retention: 6.4 kg/m3 (0.4 lb/ft3) for ACQ; 6.58 kg/m3 (0.41 lb/ft3) for CBA-A and 3.37 kg/m3 (0.21 lb/ft3) for CA-B.

.4 Minimum depth of penetration: 10mm.

.5 Contractor shall submit preservative type and % retention to the Departmental Representative for approval prior to use on the project.

.2 Treated material will be rejected if damaged in any manner during handling, including damage, including damage from strapping and slings.

.3 Do not make field cuts in treated material unless permitted by the Departmental Representative. When permitted, field treat cuts as soon as possible with preservative specified for the original timber treatment.

.4 Treated posts, logs, rails and field drilled holes: when field treating is permitted, field treat to CSA O80, using 2 coats of approved wood preservative.

.4 Primers: in accordance with manufacturer's recommendations for surface conditions:

.1 Interior Flat coating or Primer, Green Seal GS-11, VOC limit 50 g/l.

.2 Interior Non-Flat Coating or Primer, Green Seal GS-11, VOC limit 150 g/l.

.3 Sealers and undercoaters, SCAQMD Rule 1113, VOC limit 200 g/l.

2.2 Accessories

.1 Fasteners: to stainless steel Type-316 for all fasteners, unless noted otherwise.

.2 Anchor rod: to ASTM A307, hot dip galvanized, complete with nuts and washers.

.3 Side plates: to CAN/CSA-G40.20/G40.21, hot dip galvanized.

.4 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs recommended for purpose by manufacturer. Submit details to Departmental Representative for review and approval.

.5 Galvanizing: to CAN/CSA-G164, hot dip galvanized, minimum zinc coating of 610 g/m^2.

Part 3 Execution

3.1 Examination

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for rough carpentry 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 Preparation

.1 All timber or wood products will be pressure treated.

.2 Treat surfaces of all exterior use timber or wood in contact with concrete, metal and masonry with wood preservative before installation.

.3 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and 1 minute soak on plywood.

.4 Re-treat surfaces exposed by cutting, hole drilling, trimming or boring with surface-applied preservative before installation.

3.3 Installation

.1 Comply with requirements of NBC 2015, supplemented by the following paragraphs.

.2 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.

.3 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation for roof hopper.

.4 Install sleepers as indicated.

.5 Use caution when working with particle board. Use dust collectors and high quality respirator masks.

.6 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.

.7 Countersink bolts where necessary to provide clearance for other work.

3.4 Cleaning

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 – Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 Related Sections

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 74 19 - Waste Management and Disposal

.3 Section 01 61 00 - Common Product Requirements

1.2 References

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

.1 ASTM A36/A36M-14, Specification for Carbon Structural Steel.

.2 ASTM A47/A47M-99, Specification for Ferritic Malleable Iron Castings.

.3 ASTM A307-12, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.40-[97], Anti-corrosive Structural Steel Alkyd Primer.

.3 Canadian Standards Association (CSA International)

.1 CSA B111-[1974(R2003)], Wire Nails, Spikes and Staples.

.2 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.3 CAN/CSA-G164-M92(withdrawn), Hot Dip Galvanizing of Irregularly Shaped Articles.

.4 CAN/CSA-O80 Series-15, Wood Preservation.

.5 CAN/CSA-O86-14, Engineering Design in Wood.

.6 CSA O112 Series-M1977(withdrawn), CSA Standards for Wood Adhesives.

.7 CAN/CSA-O122-06 (R2011), Structural Glued-Laminated Timber.

.8 CAN/CSA-O177-06(R2011), Qualification Code for Manufacturer's of Structural Glued-Laminated Timber.

.9 CAN/CSA-S16-14, Limit States Design of Steel Structures.

.10 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.

.11 CAN/CSA-Z808-16, A Sustainable Forest Management System: Guidance Document.

1.3 Shop Drawings

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

.2 Shop drawings for members to indicate stress grade, service grade and appearance grades, shop applied finishes, camber, cuts, ledgers, holes and connection details.

1.4 Qualifications

.1 Manufacture structural glued-laminated members in plant certified by CSA as meeting requirements of CAN/CSA-O177, class X.

.2 Submit certificate in accordance with CAN/CSA-O177, Appendix B at completion of fabrication.

.3 Fabricator for welded steel connections to be certified in accordance with CSA W47.1.

.4 Place authorization labels on glued-laminated members indicating manufactured in CSA certified plant.

.5 Certification of material protective sealer.

1.5 Delivery, Storage, And Handling

.1 Deliver, handle, store and protect materials of this section in accordance with Section 01 61 00 - Common Product Requirements.

.2 Apply protective sealer to glued-laminated units before shipping unless specified otherwise.

.3 Wrap quality or commercial grade members prior to leaving plant with a moisture resistant wrapping.

.4 Use padded, non-marring slings for handling glued-laminated members.

.5 Protect corners with wood blocking.

.6 Slit underside of membrane covering during storage at site. Do not deface member.

.7 Store glued-laminated units and protect from weather, block off ground and separate with stripping, so air may circulate around all faces of members.

.8 Cover glued-laminated units with opaque moisture resistant membrane if stored outside.

.9 Make adequate provision for delivery and handling stresses.

1.6 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.

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

.3 Collect and separate for disposal packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

.5 Divert unused paint material from landfill to official hazardous material collections site approved by Departmental Representative.

.6 Do not dispose of unused paint materials or preservative material into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.

.7 Do not dispose of preservative treated wood through incineration.

.8 Do not dispose of preservative treated wood with materials destined for recycling or reuse.

.1 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Departmental Representative.

.9 Dispose of unused wood preservative material at official hazardous material collections site approved by Departmental Representative.

.10 Divert unused wood materials from landfill to recycling facility approved by Departmental Representative.

Part 2 Products

2.1 Materials

.1 Laminating stock: Douglas Fir-Larch to CAN/CSA-O122.

.2 Adhesive: to CSA O112 Series, to grade of service required in accordance with CAN/CSA-O122.

.3 Sealer for glued-laminated members: penetrating type, clear, non-yellowing liquid.

.4 Fastenings:

.1 Fasteners: to stainless steel Type-316 for all fasteners, unless noted otherwise.

.2 Anchor rod: to ASTM A307, hot dip galvanized, complete with nuts and washers.

.3 Side plates: to CAN/CSA-G40.20/G40.21, hot dip galvanized.

.4 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs recommended for purpose by manufacturer.

.5 Galvanizing: to CAN/CSA-G164, hot dipped, minimum zinc coating of 610 g/m^2.

.6 Preservative: to CSA O80 Series

2.2 Pressure Treatment of Wood Material

.1 All timber members shall be pressure treated with water-borne salts:

.1 Conform to CSA O80 Series and its current amendments.

.2 Only Alkaline Copper Quat (ACQ-C, ACQ-D, ACQ-D Carbonate) and Copper Azole (CBA-A & CA-B) will be accepted.

.3 Retention: 6.4 kg/m3 (0.4 lb/ft3) for ACQ; 6.58 kg/m3 (0.41 lb/ft3) for CBA-A and 3.37 kg/m3 (0.21 lb/ft3) for CA-B.

.4 Minimum depth of penetration: 10mm.

.5 Contractor shall submit preservative type and % retention to the Departmental Representative for approval prior to use on the project.

.2 Treated material will be rejected if damaged in any manner during handling, including damage, including damage from strapping and slings.

.3 Do not make field cuts in treated material unless permitted by the Departmental Representative. When permitted, field treat cuts as soon as possible with preservative specified for the original timber treatment.

.4 Treated posts, logs, rails and field drilled holes: when field treating is permitted, field treat to CSA O80, using 2 coats of approved wood preservative.

2.3 Fabrication

.1 Fabricate members to following classifications:

.1 Stress grade: to 24f-Ex bending grade.

.2 Service grade: Exterior.

.3 Appearance grade: Quality - where exposed to view and Industrial – where concealed.

.2 Mark laminated members for identification during erection.

.3 Do not apply sealer to areas which are to receive stained finish or preservative treatment.

.4 Design connections to CAN/CSA-O86, and CAN/CSA-S16 unless specifically detailed, to resist shears, moments and forces indicated.

.1 Fabricate in accordance with CAN/CSA-S16.

.5 Galvanize connections after fabrication.

Part 3 Execution

.1 Protect protective sealer from damage before erection.

.1 Touch up damaged areas on site with specified sealer.

.2 Erect glued-laminated members in accordance with approved erection drawings.

.3 Brace and anchor members until permanently secured by structure.

.4 Make adequate provisions for erection stresses.

.5 Splice and join only at locations as indicated on approved erection drawings.

.6 Do not field cut or alter members without Departmental Representative approval. If approved, preservative treat cut ends.

.7 Collect waste wood pieces from cutting for reuse where appropriate.

END OF SECTION

Part 1 General

1.1 Summary of Work

.1 Work of this section includes provision of a 2-ply torch applied SBS membrane over insulation, over sheathing and existing steel deck.

1.2 Related Requirements

.1 Rough Carpentry for Minor Works Section 06 08 99

1.3 References

.1 ASTM International Inc.

.1 ASTM C1177/C1177M-08, Standard Specification for Glass Mat Gypsum Substrate for use as Sheathing.

.2 ASTM D 6164-05 Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.

.2 Canadian General Standards Board (CGSB)

.1 CGSB 37-GP-9Ma-, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.

.2 CGSB 37-GP-56M-80b (A1985), Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.

.3 Roofing Contractors' Association of British Columbia R.C.A.B.C. RGC Roofing Practices Manual, guarantee standards.

.4 Canadian Standards Association (CSA International)

.1 CSA-A123.3-05, Asphalt Saturated Organic Roofing Felt.

.2 CSA-A123.4-04, Asphalt for Constructing Built-Up Roof Coverings and Waterproofing Systems.

.3 CSA O121-08, Douglas Fir Plywood.

.4 CSA O151-04, Canadian Softwood Plywood.

.5 Factory Mutual (FM Global)

.1 FM Approvals - Roofing Products.

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

.1 Material Safety Data Sheets (MSDS).

.7 Underwriters Laboratories' of Canada (ULC)

.1 CAN/ULC-S704-03, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.4 Administrative Requirements

.1 Convene pre-installation meeting two week prior to beginning waterproofing Work, with roofing contractor's representative and Departmental Representative in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building subtrades.

.4 Review installation instructions and warranty requirements.

1.5 Action and Informational Submittals

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

.2 Product Data:

.1 Provide two copies of most recent technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 33 - Health and Safety Requirements, and indicate VOC content for primers.

.3 Provide shop drawings:

.1 Indicate flashing, control joints and tapered insulation details.

.2 Provide layout for tapered insulation.

1.6 Quality Assurance

.1 Installer qualifications: company or person specializing in application of modified bituminous roofing systems with minimum 5 years experience.

.2 Inspection Authority:

.1 Selected from RCABC Approved list of Roofing Inspectors.

.2 The presence of an Inspector shall in no way excuse the Contractor from performing the Work in accordance with the contract Documents and keeping with the best practices of the trades.

.3 The Inspector will not be responsible for or have control or charge over safety precautions and programs required for the Work in accordance with the applicable construction safety legislation, other regulations or general construction practice, the acts or omissions of the contractor, his subcontractors or their agents, employees or other persons performing any of the Work.

.4 The Contractor shall inform the Inspection Agency seven (7) days prior to commencement of work.

1.7 Fire Protection

.1 Fire Extinguishers:

.1 Maintain one cartridge operated type with shut-off nozzle, on roof per torch applicator, within 6 m of torch applicator.

.2 ULC labelled for A, B and C class protection.

.2 Maintain fire watch for 1 hour after each day's roofing operations cease.

1.8 Delivery, Storage, And Handling

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Storage and Handling Requirements:

.1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.

.2 Provide and maintain dry, off-ground weatherproof storage.

.3 Store rolls of membrane in upright position. Store membrane rolls with salvage edge up.

.4 Remove only in quantities required for same day use.

.5 Place plywood runways over completed Work to enable movement of material and other traffic.

.6 Store sealants at +5 degrees C minimum.

.7 Store insulation protected from daylight and weather and deleterious materials.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials in accordance with Section 01 74 19 - Waste Management and Disposal.

1.9 Site Conditions

.1 Ambient Conditions

.1 Do not install roofing when temperature remains below -18 degrees C for torch application, or -5 degrees C for mop application.

.2 Minimum temperature for solvent-based adhesive is -5 degrees C.

.2 Install roofing on dry deck, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roofing system.

1.10 Warranty

.1 Contractor to retain existing base building roofing contractor for all roofing work and to maintain the existing roofing warranty.

Part 2 Products

2.1 Performance Criteria

.1 Compatibility between components of roofing system is essential. Provide written declaration to Departmental Representative stating that materials and components, as assembled in system, meet this requirement.

2.2 Deck Covering

.1 Gypsum board sheathing: to ASTM C1177/C1177 M-08 Standard 15.9 mm thick Glass Mat Gypsum Sheathing.

2.3 Deck Primer

.1 Asphalt primer: to CGSB 37-GP-9Ma.

2.4 Vapour Retarder

.1 Base sheet vapour retarder: to CGSB 37-GP-56M, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, polyester reinforcement, weighing 180 g/m².

.1 Top and bottom surfaces: sanded/thermofusible.

2.5 Membrane

.1 Base sheet: to CGSB 37-GP-56M polyester fibres to ASTM D 6164.

.1 Styrene-Butadiene-Styrene (SBS) elastomeric polymer prefabricated sheet, polyester reinforcement, having nominal weight of 180 g/m².

.2 Type 1, torch on.

.3 Grade 1 - standard service.

.4 Top and bottom surfaces:

.1 Thermofusible.

.5 Base sheet membrane properties: to CGSB 37-GP-56M.

.1 Strain energy (longitudinal/transversal): 9.0/7.0 kN/m.

.2 Breaking strength (longitudinal/transversal): 17.0/18.0 N/5 cm.

.3 Ultimate elongation (longitudinal/transversal): 60/70.

.4 Tear resistance: 85 N.

.5 Cold bending at -30 degrees C: no cracking.

.6 Softening point: ò 110 degrees C.

.7 Static puncture resistance: > 400.

.8 Dimensional Stability: -0.3 / 0.3 %.

.6 ULC certification: Class A.

.2 Cap sheet membrane: to CGSB 37-GP-56M polyester fibres to ASTM D 6164.

.1 Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, polyester reinforcement, having nominal weight of 250 g/m².

.2 Type 1, torched on.

.3 Class A-granule surfaced.

.1 Colour for granular surface: red.

.4 Grade 1-standard service.

.5 Bottom surface: thermofusible.

.6 Cap sheet membrane properties: to CGSB 37-GP-56M.

.1 Strain energy (longitudinal/transversal): 13.0/10.0kN/m.

.2 Breaking strength (longitudinal/transversal): 25.0/16.0 kN/m.

.3 Ultimate elongation (longitudinal/transversal): 63/73 60/65 %.

.4 Tear resistance: 80 N.

.5 Cold bending at -30 degrees C: No cracking.

.6 Softening point: ò 110 degrees C.

.7 Static puncture resistance: > 400 370.

.8 Dimensional Stability: -0.2 / 0.2%.

.7 ULC certification: Class A.

2.6 Overlay Board

.1 Overlay Board: 6mm thick asphalt impregnated fiberboard.

.1 Install over insulation to provide torch safe surface.

2.7 Bitumen

.1 Asphalt: to CAN/CSA A123.4 ASTM D 312 , Type 2 3.

2.8 Polyisocyanurate Insulation

.1 Roof Insulation Polyisocyanurate: Thickness to match existing roof, conforming to CAN/CGSB-51.26-M86 factory finished both sides with a nominal 2 lb./ft³ density, compressive strength of 140 Kpa (20 psi) minimum and meet ULC S704. Facers must not have organic matter.

.2 Create cricket as required to provide positive slope towards existing roof drain.

.3 Tapered insulation required to provide positive slope towards existing roof drain.

2.9 Sealers

.1 Sealing compound: rubber asphalt type.

.2 Caulking - see Section 07 92 00 - Joint Sealants.

2.10 Walkways

.1 Walkways to consist of one additional ply of cap sheet membrane. Colour to be different from field membrane as selected by Departmental Representative.

2.11 Carpentry

.1 Refer to Section 06 08 99 - Rough Carpentry Minor Works.

2.12 Fasteners

.1 Covering to steel deck: No. 10 flat head, self-tapping, Type A or AB, cadmium plated screws. Recommend FM Approved screw and plate assemblies.

.2 Insulation to deck: coated insulation fasteners and galvanized plates must meet FM Approval for wind uplift and corrosion resistance, as recommended by insulation manufacturer.

Part 3 Execution

3.1 Quality of Work

.1 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and RCABC Roofing Specification Manual to meet specified Guarantee standards, particularly for fire safety precautions.

.2 Do priming in accordance with manufacturers written recommendations.

.3 The interface of the walls and roof assemblies will be fitted with durable rigid material providing connection point for continuity of air barrier.

.4 Assembly, component and material connections will be made in consideration of appropriate design loads.

3.2 Examination of Roof Decks

.1 Verification of Conditions:

.1 Inspect with Departmental Representative deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed.

.2 Evaluation and Assessment:

.1 Prior to beginning of work ensure:

.1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.

.2 Curbs have been built.

.3 Roof drains have been installed at proper elevations relative to finished roof surface.

.4 Plywood and lumber nailer plates have been installed to deck, walls and parapets as indicated.

.3 Do not install roofing materials during rain or snowfall.

3.3 Protection of In-Place Conditions

.1 Cover walls, walks and adjacent work where materials hoisted or used.

.2 Use warning signs and barriers. Maintain in good order until completion of Work.

.3 Clean off drips and smears of bituminous material immediately.

.4 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.

.5 Protect roof from traffic and damage. Comply with precautions deemed necessary by Departmental Representative.

.6 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed Work and materials out of storage.

.7 Metal connectors and decking will be treated with rust proofing or galvanization.

3.4 Deck Sheathing

.1 Mechanically fasten to steel deck Gypsum Board Sheathing with screws to steel deck's upper rib surfaces, spaced 400 mm on centre each way.

.2 Place with long axis of each sheet transverse to steel deck ribs, with end joints staggered and fully supported on ribs.

3.5 Vapour Retarder

.1 Install peel and stick continuous over installed gypsum sheathing. Extend up vertical surfaces as shown and tie into air/vapour barrier as indicated or required.

3.6 Conventional Membrane Roofing

.1 Insulation: mechanically fastened application:

.1 Mechanically fasten insulation using screws and pressure distribution plates.

.2 Fasten insulation as per manufacturer's written recommendations.

.3 Number and pattern of screws per board to meet Factory Mutual requirements.

.4 Place boards in parallel rows with ends staggered, and in firm contact with one another.

.5 Cut end boards to suit.

.2 Tapered insulation application:

.1 Install tapered insulation as second insulation layer, in accordance with shop drawings. Stagger joints between layers 150 mm minimum.

.3 Overlay Board:

.1 Place boards in parallel rows with end joints staggered, mechanically fastened to steel deck.

.4 Base sheet application:

.1 Starting at low point of roof, perpendicular to slope, unroll base sheet, align and reroll from both ends.

.2 Unroll and torch base sheet onto substrate taking care not to burn membrane or its reinforcement or substrate.

.3 Lap sheets 75 mm minimum for side and 150 mm minimum for end laps.

.4 Application to be free of blisters, wrinkles and fishmouths.

.5 Cap sheet application:

.1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, align and reroll from both ends.

.2 Unroll and torch cap sheet onto base sheet taking care not to burn membrane or its reinforcement.

.3 Lap sheets 75 mm minimum for side laps and 150 mm minimum for end laps. Offset joints in cap sheet 300 mm minimum from those in base sheet.

.4 Application to be free of blisters, fishmouths and wrinkles.

.5 Do membrane application in accordance with manufacturer's recommendations.

.6 Flashings:

.1 Complete installation of flashing base sheet stripping prior to installing membrane cap sheet.

.2 Torch base and cap sheet onto substrate in 1 metre wide strips.

.3 Lap flashing base sheet to membrane base sheet minimum 150 mm and seal by mopping or torch welding.

.4 Lap flashing cap sheet to membrane cap sheet 250 mm minimum and torch weld.

.5 Provide 75 mm minimum side lap and seal.

.6 Properly secure flashings to their support, without sags, blisters, fishmouths or wrinkles.

.7 Do work in accordance with Section 07 62 00 - Sheet Metal Flashing and Trim.

.7 Roof penetrations:

.1 Install roof drain pans, vent stack covers and other roof penetration flashings and seal to membrane in accordance with manufacturer's recommendations and details and Section.

3.7 Walkways

.1 Install walkway membrane in accordance with manufacturer's instructions and as indicated.

.1 Apply primer to cap sheet membrane and torch apply, ensuring selvage edge is removed.

.2 Install concrete paver at cat ladder landing, level on insulation pads, as indicated.

3.8 Field Quality Control

.1 Inspections:

.1 Inspection and testing of roofing systems and application will be carried out by testing laboratory designated by Departmental Representative.

.2 Inspection will be carried out during the entire roof installation procedure.

3.9 Cleaning

.1 Remove bituminous markings from finished surfaces.

.2 In areas where finished surfaces are soiled caused by work of this section, consult manufacturer of surfaces for cleaning advice and complying with their documented instructions.

.3 Repair or replace defaced or disfigured finishes caused by work of this section.

.4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.1 Place materials defined as hazardous or toxic in designated containers.

.2 Ensure emptied containers are sealed and stored safely.

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

.4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

.5 Dispose of unused sealant material at official hazardous material collections site approved by Departmental Representative.

.6 Divert unused gypsum materials from landfill to recycling facility as reviewed by Departmental Representative.

END OF SECTION

Part 1 General

1.1 Related Requirements

.1 Rough Carpentry for Minor Works Section 06 08 99

.2 Modified Bituminous Membrane Roofing Section 07 52 00

1.2 References

.1 The Aluminum Association Inc. (AAI)

.1 AAI-Aluminum Sheet Metal Work in Building Construction-2002.

.2 AAI DAF45-03, Designation System for Aluminum Finishes.

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

.1 ASTM A 653/A 653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.2 ASTM A 792/A 792M-10, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

.3 Roofing Contractors Association of B.C. (RCABC)

.1 RGC Roofing Practice Manual.

.4 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type.

.5 Canadian Standards Association (CSA International)

.1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.

.6 Green Seal Environmental Standards

.1 Standard GS-03-93, Anti-Corrosive Paints.

.2 Standard GS-11-97, Architectural Paints.

.3 Standard GS-36-00, Commercial Adhesives.

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

.1 Material Safety Data Sheets (MSDS).

.8 British Columbia Sheet Metal Association (SMACNA-BC)

.1 Architectural Sheet Metal Manual- latest Edition.

1.3 Submittals

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

.2 Product Data:

.1 Submit manufacturer's printed product literature for sheet metal flashing systems materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 33 - Health and Safety Requirements.

.3 Samples:

.1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colours.

.4 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.

.1 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.4 Quality Assurance

.1 Pre-Installation Meetings: convene pre-installation meeting [one] week prior to beginning work of this Section and, with contractor's representative, Departmental Representative to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building sub trades.

.4 Review manufacturer's installation instructions and warranty requirements.

.2 Upon completion of work, this Contractor shall provide a 5 year R.C.A.B.C. guarantee work of this section.

.3 Provide for inspection in accordance with specifications and as deemed required to adhere to RCABC standards. Include inspection fees in this contract. Inspection agency to be selected from R.C.A.B.C. approved list of roofing inspectors.

1.5 Delivery, Storage and Handling

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Waste Management and Disposal:

.1 Separate waste materials for and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 Pre-Finished Sheet Metal

.1 Zinc coated steel sheet: 0.91 mm (20ga) thickness, commercial quality to ASTM A 792, with Z275 designation zinc coating, finish enamel coated factory applied coating to CGSB 93-GP-3m Class F29, color to match profiled metal panels as shown on drawing.

2.2 Prefinished Aluminum Sheet

.1 Prefinished aluminum sheet: 0.81mm (20 gauge).

2.3 Accessories

.1 Isolation coating: alkali resistant bituminous paint.

.2 Plastic cement: to CAN/CGSB 37.5.

.1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.

.3 Underlay for metal flashing: asphalt laminated 3.6 to 4.5 kg kraft paper.

.4 Sealants.

.1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.

.5 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.

.6 Fasteners: stainless steel, flat head roofing nails of length and thickness suitable for metal flashing application.

.7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

.8 Touch-up paint: as recommended by prefinished material manufacturer.

.1 Maximum VOC limit 50 g/L to SCAQMD Rule 1113.

2.4 Fabrication

.1 Fabricate metal flashings and other sheet metal work in accordance with applicable RCABC and SMACNA Standards. Guarantee standard as specified in 1.4 Quality Assurance.

.2 Form pieces in 2400 mm maximum lengths.

.1 Make allowance for expansion at joints.

.3 Hem exposed edges on underside 12 mm.

.1 Mitre and seal corners with sealant.

.4 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.5 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

2.5 Metal Flashings

.1 Form flashings, copings and fascia to profiles indicated of galvanized steel as indicated on drawings.

.2 Caulk perimeter flashings with specified sealant where necessary to make a proper seal.

.3 'S' Lock and caulk end joints in flashing. Provide standing seams with concealed clips at corners. Hem exposed edges of flashing a minimum of 12.5 mm for rigidity.

.4 Provide flashings with edges turned to form a drip. Make proper allowance for expansion and contraction. Face clip flashings with concealed clips (600 mm) on centres.

.5 Provide flashings at vents, chimneys and control joints.

.6 Carry face metal down exterior face a minimum of 100 mm or as indicated on drawings.

.7 Provide metal base and cap flashings to extend to within 25 mm of roof surface.

.8 At vent stacks, install aluminum vent stacks and include for aluminum metal caps.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 Installation

.1 Install sheet metal work in accordance with R.C.A.B.C standards. Guarantee standard as per 1.4 Quality Assurance.

.2 Use concealed fastenings except where approved before installation.

.3 Provide underlay under sheet metal.

.1 Secure in place and lap joints 100 mm.

.4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.

.1 Flash joints using S-lock forming tight fit over hook strips.

.5 Lock end joints and caulk with sealant.

.6 Install pans, where shown around items projecting through roof membrane.

3.3 Cleaning

.1 Proceed in accordance with Section 01 74 11 – Cleaning and Special Cleaning Procedures.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

.3 Leave work areas clean, free from grease, finger marks and stains.

END OF SECTION

Part 1 General

1.1 Related Requirements

.1 Rough Carpentry for Minor Works Section 06 08 99

1.2 References

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

.1 Material Safety Data Sheets (MSDS).

.2 Underwriter's Laboratories of Canada (CAN/ULC)

.1 CAN/ULC-S101 Fire Endurance Tests of Building Construction and Materials.

.2 CAN/ULC-S102 Surface Burning Characteristics of Building Materials and Assemblies.

.3 CAN/ULC-S115-07, Fire Tests of Fire Stop Systems.

1.3 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 Tightly Fitted; (ref: NBC 2015): penetrating items that are cast in place in buildings of non-combustible construction or have "0" annular space in buildings of combustible construction.

.1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.4 Submittals

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

.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 in accordance with Section 01 35 33 - Health and Safety Requirements.

.3 Shop Drawings:

.1 Submit shop drawings to show location, proposed material, reinforcement, anchorage, fastenings, and method of installation for each type of firestop condition.

.2 Construction details should accurately reflect actual job conditions.

.4 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.

.1 Test reports: in accordance with CAN/ULC-S101 and CAN/ULC-S102.

.1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.

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

.3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

.4 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 – 3.5 FIELD QUALITY CONTROL.

1.5 Quality Assurance

.1 Qualifications:

.1 Installer: company specializing in fire stopping installations with 5 years documented experience and certified by manufacturer of firestop system.

.2 Pre-Installation Meetings: convene pre-installation meeting two weeks prior to beginning work of this Section, with contractor's representative and Departmental Representative to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building sub trades.

.4 Review manufacturer's installation instructions and warranty requirements.

.3 Site Meetings: as part of Manufacturer's Services described in PART 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.

.1 After delivery and storage of products, and when preparatory Work is complete, but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of Work, after cleaning is carried out.

1.6 Delivery, Storage and Handling

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

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

.3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.

.2 Storage and Protection:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.3 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 19 Waste Management and Disposal.

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 and conforming to specified special requirements described in PART 3.

.2 Fire stop system rating: 1-hour FRR, F rating.

.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 2015 and BCBC 2012.

.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 without interruption to vapour barrier.

.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 Mechanical pipe insulation: 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 Fire Stop Label

.1 All fire stop penetrations shall be labeled. Labels shall be secured to surface directly on both sides of fire stop penetration. Fire stop penetration labels shall include the following information.

.1 Name of installer.

.2 Date of installation.

.3 Type of sealing system.

.4 Time duration of sealant.

3.7 Cleaning

.1 Proceed in accordance with Section 01 74 11 Cleaning and Special Cleaning Procedures.

.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 fires stopping and smoke seal materials.

3.8 Schedule

.1 Fire stop and smoke seal at:

.1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.

.2 Top of fire-resistance rated masonry and gypsum board partitions.

.3 Intersection of fire-resistance rated masonry and gypsum board partitions.

.4 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.

.5 Penetrations through fire-resistance rated floor slabs, ceilings, and roofs.

.6 Openings and sleeves installed for future use through fire separations.

.7 Around mechanical and electrical assemblies penetrating fire separations.

.8 Rigid ducts: 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.

END OF SECTION

Part 1 General

1.1 Related Requirements

.1 Rough Carpentry for Minor Works — Section 06 08 99

.2 Modified Bituminous Membrane Roofing — Section 07 52 00

.3 Sheet Metal Flashing and Trim — Section 07 62 00

1.2 References

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

.1 ASTM C 919-12, Standard Practice for Use of Sealants in Acoustical Applications.

.2 ASTM C920-11 Standard Specification for Elastomeric Joint Sealants

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

.1 Material Safety Data Sheets (MSDS).

1.3 Submittals

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

.2 Manufacturer's product to describe.

.1 Caulking compound.

.2 Primers.

.3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.

.3 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

.4 Submit duplicate samples of each type of material and colour

.5 Cured samples of exposed sealants for each color where required to match adjacent material.

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

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

1.4 Delivery, Storage & Handling

.1 Deliver, handle, store and protect materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor

.3 Upon completion of Work, after cleaning is carried out.

1.5 Environmental Requirements

.1 Environmental Limitations:

.1 Do not proceed with installation of joint sealants under following conditions:

.2 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C.

.3 When joint substrates are wet.

.2 Joint-Width Conditions:

.1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

.3 Joint-Substrate Conditions:

.1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

.4 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.

.5 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

.6 Ventilate area of work as directed by Departmental Representative by use of approved portable supply and exhaust fans.

Part 2 Products

2.1 Sealant Materials

.1 Do not use caulking that emits strong odours, contains toxic chemicals, or is not certified as mould resistant in air handling units.

.2 When low toxicity caulks are not possible, confine usage to areas which offgas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize off gas time.

.3 Where sealants are qualified with primers use only these primers.

.4 Standard: For interior and exterior work unless otherwise specified, ensure compatibility of sealants being used and other materials in contact with them, meet VOC level of 250 g/L for architectural sealant.

2.2 Sealant Type

.1 S-1:

.1 ASTM C920, polyurethane or polysulfide.

.2 Type M.

.3 Class 25.

.4 Grade NS.

.5 Shore A hardness of 20-40.

.2 S-2:

.1 ASTM C920, polyurethane or polysulfide.

.2 Type M.

.3 Class 25.

.4 Grade P.

.5 Shore A hardness of 25-40.

.3 S-3:

.1 ASTM C920, silicone, neutral cure.

.2 Type S.

.3 Class: Joint movement range of plus 100 percent to minus 50 percent.

.4 Grade NS.

.5 Shore A hardness of 15-20.

.6 Minimum elongation of 1200 percent.

2.3 Caulking Compound

.1 C-1: ASTM C834, acrylic latex.

.2 C-2: One component acoustical caulking, non-drying, non-hardening, synthetic rubber.

2.4 Joint Cleaner

.1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

.2 Primer: as recommended by manufacturer.

Part 3 Execution

3.1 Protection

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

3.2 Surface Preparation

.1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.

.2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.

.3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.

.4 Ensure joint surfaces are dry and frost free.

.5 Prepare surfaces in accordance with manufacturer's directions.

3.3 Priming

.1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.

.2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 Backup Material

.1 Apply bond breaker tape where required to manufacturer's instructions.

.2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 Mixing

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

3.6 Application

.1 Sealant.

.1 Apply sealant in accordance with manufacturer's written instructions and ASTM C919.

.2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.

.3 Apply sealant in continuous beads.

.4 Apply sealant using gun with proper size nozzle.

.5 Use sufficient pressure to fill voids and joints solid.

.6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.

.7 Tool exposed surfaces before skinning begins to give slightly concave shape.

.8 Remove excess compound promptly as work progresses and upon completion.

.2 Curing.

.1 Cure sealants in accordance with sealant manufacturer's instructions.

.2 Do not cover up sealants until proper curing has taken place.

.3 Cleanup.

.1 Clean adjacent surfaces immediately and leave Work neat and clean.

.2 Remove excess and droppings, using recommended cleaners as work progresses.

.3 Remove masking tape after initial set of sealants.

3.7 Cleaning

.1 Clean adjacent surfaces immediately and leave work clean and neat. Remove excess sealant and droppings using recommended cleaners as work progresses. Remove masking after tooling of joints.

3.8 Locations

.1 Exterior Building Joints, Horizontal and Vertical:

.1 Metal to Metal: Type S-1, S-2.

.2 Metal Reglets and Flashings:

.1 Flashings to Wall: Type S-3.

.2 Metal to Metal: Type S-3.

END OF SECTION

Part 1 General

1.1 Related Requirements

.1 Section 05 12 23 – Structural Steel Framing

1.2 References

.1 Environmental Protection Agency (EPA)

.1 Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings).

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

.1 Safety Data Sheets (SDS).

.3 The Master Painters Institute (MPI)

.1 Architectural Painting Specification Manual – November 2007.

.2 Standard GPS-1- 05, MPI Green Performance Standard for Painting and Coatings.

.4 National Fire Code of Canada 2010.

.5 Society for Protective Coatings (SSPC)

.1 Systems and Specifications, SSPC Painting Manual 2005.

1.3 Quality Assurance

.1 Conform to the standards contained in the Master Painters Institute Architectural Painting Specification Manual, latest edition (hereafter referred to as MPI Painting Specification Manual) for all painting products including preparation and application of materials. MPI Painting Specification Manual as issued by the local MPI Accredited Quality Assurance Association having jurisdiction.

.2 All paint manufacturers and products used shall be as listed under the "Approved Products" section of the MPI Painting Specification manual.

.3 Other paint materials 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.

.4 Single-Source Responsibility: provide primers and undercoat paint produced by the same manufacturer as the finish coat.

.5 All painting and decorating work shall be inspected by Paint Inspection Agency (inspector) acceptable to the specifying authority and the local MPI Accredited Quality Assurance Association. The painting contractor shall notify the Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of the project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.

.6 All surfaces requiring painting or repainting shall be inspected by the inspection agency who shall advise on all aspects of painting work including preparation, notifying the Departmental Representative, the Contractor and the Trade Contractor of any defects or problems prior to commencing painting work or after the prime coat shows defects in the substrate, and as the work progresses.

.7 Standard of Acceptance:

.1 Wall: No defects visible from a distance of 1000mm at 90° to surface.

.2 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

.8 Mock-Ups:

.1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.

.1 Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen, textures.

.2 Mock-up will be used:

.1 To judge workmanship, substrate preparation, operation of equipment and material application and workmanship to MPI Architectural Painting Specification Manual standards.

.3 Locate where directed.

.4 Allow 24 hours for inspection of mock-up before proceeding with work.

.5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

.9 Pre-Installation Meeting:

.1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Coordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

.10 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 33 Health and Safety Requirements.

1.4 Performance Requirements

1.5 Scheduling

.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 Departmental Representative for changes in work schedule.

.3 Schedule painting operations to prevent disruption of occupants in and about building.

1.6 Submittals

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

.2 Product Data:

.1 Submit product data and instructions for each paint and coating product to be used.

.2 Submit product data for the use and application of paint thinner.

.3 Samples:

.1 Submit manufacturer's standard range of color choices on each specified color type as listed in Colour Schedule of this section for selection, review and acceptance of each color.

.2 Submit triplicates 200 x 300 mm sample panels of each paint with specified paint in colours, gloss/sheen and textures required, based on selected colors, to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:

.1 1 mm plate steel for finishes over metal surfaces.

.3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.

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

.5 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions.

.6 Closeout Submittals: submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include following:

.1 Product name, type and use.

.2 Manufacturer's product number.

.3 Colour numbers.

.4 MPI Environmentally Friendly classification system rating.

1.7 Maintenance

.1 Extra Materials:

.1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Section01 78 00 Closeout Submittals.

.2 Delivery, storage and protection: comply with Departmental Representative requirements for delivery and storage of extra materials.

1.8 Delivery, Storage & Handling

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements, supplemented as follows:

.1 Deliver and store materials in original containers, sealed, with labels intact.

.2 Labels: to 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 well-ventilated area with temperature range 7 degrees C to 30 degrees 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 Departmental Representative. 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 9 kg Type ABC dry chemical 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.

.2 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Paint, stain and wood preservative finishes and related materials (thinners, solvents, etc.) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.

.3 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.

.4 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.

.5 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground the following procedures shall be strictly adhered to:

.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.

.2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.

.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.

.4 Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.

.5 Empty paint cans are to be dry prior to disposal or recycling (where available).

.6 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

.7 Set aside and protect surplus and uncontaminated finish materials: Deliver to or arrange collection by employees, individuals, or organizations for verifiable re-use or re-manufacturing.

.8 Close and seal tightly partly used sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.

1.9 Ambient Conditions

.1 Heating, Ventilation and Lighting:

.1 Perform no painting work unless a minimum lighting level of 323 Lux is provided on surfaces to be painted. Adequate lighting facilities to be provided by General Contractor.

.2 Temperature, Humidity and Substrate Moisture Content Levels:

.1 Unless specifically pre-approved by specifying body, Paint Inspection Agency and, applied product manufacturer, perform no painting work when:

.1 Ambient air and substrate temperatures are below 10 degrees C.

.2 Substrate temperature is over 32 degrees 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 Relative humidity is above 85 % or when dew point is less than 3 degrees C variance between 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.

.3 Surface and Environmental Conditions:

.1 Apply paint finish 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 to adequately prepared surfaces and to surfaces within moisture limits noted herein.

.3 Apply paint when previous coat of paint is dry or adequately cured.

.4 Apply paint finishes when conditions forecast for entire period of application fall within manufacturer's recommendations.

.5 Do not apply paint when:

.1 Temperature is expected to drop below 10 degrees C before paint has thoroughly cured.

.2 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's limits.

.3 Surface to be painted is wet, damp or frosted.

.6 Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by manufacturer. Protect until paint is dry or until weather conditions are suitable.

.7 Schedule painting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.

.8 Remove paint from areas which have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.

.9 Paint occupied facilities in accordance with approved schedule only. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

1.10 Guarantee

.1 Furnish the local MPI Accredited Quality Assurance Association's two (2) year guarantee.

.2 All painting and decorating work shall be in accordance with MPI Painting Manual requirements and shall be inspected by the local MPI Accredited Quality Assurance Association's Paint Inspection Agency (inspector). The cost for such inspections, and for the local MPI Accredited Quality Assurance Association's Guarantee.

Part 2 Products

2.1 Materials

.1 Paint materials listed in latest edition of MPI Approved Products List (APL) are acceptable for use on this project.

.2 Paint materials for paint systems: to be products of single manufacturer.

.3 Only qualified products with E2 “Environmentally Friendly" ratings are acceptable for use on this project.

.4 Use only MPI listed materials.

.5 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids, to be as follows:

.1 Be water-based.

.2 Be non-flammable biodegradable.

.3 Be manufactured without compounds which contribute to ozone depletion in 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.

.6 Water-borne surface coatings must be manufactured and transported in a manner that steps of processes, including disposal of waste products arising therefrom, will meet requirements of applicable governmental acts, by-laws and regulations including, for facilities located in Canada.

.7 Water-borne surface coatings must not be formulated or manufactured with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavelant chromium or their compounds.

.8 Water-borne surface coatings and recycled water-borne surface coatings must have flash point of 61.0 degrees C or greater.

.9 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 15 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.

.10 Recycled water-borne surface coatings must contain 50 % post-consumer material by volume.

.11 Recycled water-borne surface coatings must not contain:

.1 Lead in excess of 600.0 ppm weight/weight total solids.

.2 Mercury in excess of 50.0 ppm weight/weight total product.

.3 Cadmium in excess of 1.0 ppm weight/weight total product.

.4 Hexavelant chromium in excess of 3.0 ppm weight/weight total product.

.5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

.12 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 Departmental Representative will provide Colour Schedule after Contract award. Submit proposed Colour Schedule to Departmental Representative for approval.

.2 Colour schedule will be based upon selection of three base colours.

.3 Selection of colours will be from manufacturer's full range of colours.

.4 Where specific products are available in restricted range of colours, selection will be based on limited range.

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 Mix paste, powder, or catalyzed paint mixes in accordance with manufacturer's written instructions.

.3 Add thinner to paint manufacturer's recommendations. Do not use kerosene or organic solvents to thin water-based paints.

.4 Thin paint for spraying according in 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 is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 Matte	Max.5	Max.10
Finish (flat) Gloss Level 2 -Velvet-Like Finish	Max.10	10 to 35
Gloss Level 3 -Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 -Satin-Like Finish	20 to 35	Min.35
Gloss Level 5 -Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 -Gloss finish	70 to 85	
Gloss Level 7 -High Gloss Finish	More than 85	

.2 Gloss level ratings of painted surfaces as indicated.

2.5 Exterior Painting Systems

.1 Structural Steel and Metal Fabrications:

.1 EXT 5.1B - Waterborne light industrial, gloss level 6 coating (over inorganic zinc).

.2 Galvanized Metal: not chromate passivated

.1 EXT 5.3G - Waterborne light industrial, gloss level 6 coating.

.3 All paint systems to be MPI Premium Grade 3 coat system.

Part 3 Execution

3.1 Manufacturer's Instructions

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

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 unfavorable conditions before proceeding with work.

3.3 Examination

.1 Exterior repainting work: inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor to notify Paint Inspection Agency minimum of one week prior to commencement of work and provide copy of project repainting specification and Finish Schedule.

.2 Exterior surfaces requiring repainting: inspected by both painting contractor and Paint Inspection Agency who will notify Departmental Representative in writing of defects or problems, prior to commencing repainting work, or after surface preparation if unseen substrate damage is discovered.

.3 Where assessed degree of surface degradation of DSD-1 to DSD-3 before preparation of surfaces for repainting is revealed to be DSD-4 after preparation, repair or replacement of such unforeseen defects discovered are to be corrected, as mutually agreed, before repainting is started.

3.4 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 passing pedestrians, building occupants and general public in and about building.

.5 Remove light fixtures, surface hardware on doors, and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Store items and re-install after painting is completed.

.6 Move and cover exterior 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 pedestrian and vehicle traffic areas to approval of Departmental Representative.

3.5 Application

.1 Method of application to be as approved by Departmental Representative. 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 Spray Application:

.1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.

.2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

.3 Apply paint in a uniform layer, with overlapping at edges of spray pattern.

.4 Brush out immediately runs and sags.

.5 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray.

.4 Use dipping, sheepskins or daubers when no other method is practical in places of difficult access and when specifically authorized by Departmental Representative.

.5 Apply coats of paint as continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.7 Sand and dust between coats to remove visible defects.

.8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as projecting ledges.

.9 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 exterior exposed conduits, piping, hangers, duct work and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as noted otherwise.

.2 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.

.3 Do not paint over nameplates.

3.7 Restoration & Cleaning

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on 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.

.6 Proceed in accordance with Section 01 74 11 – Cleaning and Special Cleaning Procedures.

.1 Remove paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.

3.8 Colour Schedule

.1 Steel support frames – medium grey.

.2 Mechanical equipment shop finished by supplier– to be selected from manufacturer's full range by Departmental Representative

END OF SECTION

Part 1 General

1.1 Related Requirements

.1 Section 05 12 23 – Structural Steel Framing

.2 Section 06 08 99 – Rough Carpentry

1.2 References

.1 Department of Justice Canada (Jus)

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33

.2 Environmental Protection Agency (EPA)

.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).

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

.1 Material Safety Data Sheets (MSDS).

.4 Master Painters Institute (MPI)

.1 MPI Architectural Painting Specifications Manual, November 2007.

.2 MPI Maintenance Repainting Manual, latest edition.

.5 National Fire Code of Canada - 2010

.6 Society for Protective Coatings (SSPC)

.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

1.3 Quality Assurance

.1 Qualifications:

.1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.

.2 Journeymen: qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.

.3 Apprentices: working under direct supervision of qualified trade's person in accordance with trade regulations.

.2 Conform to the standards contained in the Master Painters Institute Architectural Painting Specification Manual, latest edition (hereafter referred to as MPI Painting Specification Manual) for all painting products including preparation and application of materials. MPI Painting Specification Manual as issued by the local MPI Accredited Quality Assurance Association having jurisdiction.

.3 All paint manufacturers and products used shall be as listed under the "Approved Products" section of the MPI Painting Specification manual.

.4 Other paint materials 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.

.5 Single-Source Responsibility: provide primers and undercoat paint produced by the same manufacturer as the finish coat.

.6 All painting and decorating work shall be inspected by Paint Inspection Agency (inspector) acceptable to the specifying authority and the local MPI Accredited Quality Assurance Association. The painting contractor shall notify the Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of the project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.

.7 All surfaces requiring painting or repainting shall be inspected by the inspection agency who shall advise on all aspects of painting work including preparation, notifying the Department Representative, the Contractor and the Trade Contractor of any defects or problems prior to commencing painting work or after the prime coat shows defects in the substrate, and as the work progresses.

.8 Mock-Ups:

.1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.

.1 Prepare and paint designated surface, area, room or item (in each colour scheme) to specified requirements, with specified paint or coating showing selected colours, gloss/sheen, textures.

.2 Mock-up will be used:

.1 To judge workmanship, substrate preparation, operation of equipment and material application and workmanship to MPI Architectural Painting Specification Manual standards.

.3 Locate where directed.

.4 Allow 24 hours for inspection of mock-up before proceeding with work.

.5 When accepted, mock-up will demonstrate minimum standard of quality required for this work. Approved mock-up may remain as part of finished work.

.9 Pre-Installation Meeting:

.1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Coordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

.10 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 33 Health and Safety Requirements.

1.4 Performance Requirements

.1 Environmental Performance Requirements:

.1 Provide paint products meeting MPI "Environmentally Friendly" E2 ratings based on VOC (EPA Method 24) content levels.

.2 Green Performance in accordance with MPI Standard GPS-1.

1.5 Scheduling

.1 Submit work schedule for various stages of painting to Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.

.2 Obtain written authorization from Departmental Representative for changes in work schedule.

.3 Schedule painting operations to prevent disruption of occupants.

1.6 Submittals

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

.2 Product Data:

.1 Submit product data and instructions for each paint and coating product to be used.

.2 Submit product data for the use and application of paint thinner.

.3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 35 33 - Health and Safety Requirements.

.3 Samples:

.1 Submit manufacturer’s standard range of color choices on each specified color type as listed in Colour Schedule of this section for selection, review and acceptance of each color.

.2 Submit triplicates 200 x 300 mm sample panels of each paint with specified paint in colours, gloss/sheen and textures required, based on selected colors, to MPI Architectural Painting Specification Manual standards submitted on 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 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface. 50mm concrete block for finishes over concrete or concrete masonry surfaces.

.4 Test reports: submit certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.1 Lead, cadmium and chromium: presence of and amounts.

.2 Mercury: presence of and amounts.

.3 Organochlorines and PCBs: presence of and amounts.

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

.6 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions.

.7 Closeout Submittals: submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include following:

.1 Product name, type and use.

.2 Manufacturer's product number.

.3 Colour numbers.

.4 MPI Environmentally Friendly classification system rating.

1.7 Maintenance

.1 Extra Materials:

.1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Section 01 78 00 - Closeout Submittals.

.2 Quantity: provide one - 4 litre (1 gallon) can of each type and colour of primer stain finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

.3 Delivery, storage and protection: comply with Departmental Representative requirements for delivery and storage of extra materials.

1.8 Delivery, Storage and Handling

.1 Packing, Shipping, Handling and Unloading:

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

.2 Acceptance at Site:

.1 Identify products and materials with labels indicating:

.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 Storage and Protection:

.1 Provide and maintain dry, temperature controlled, secure storage.

.2 Store materials and supplies away from heat generating devices.

.3 Store materials and equipment in well-ventilated area with temperature range 7 degrees C to 30 degrees C.

.5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

.7 Remove paint materials from storage only in quantities required for same day use.

.8 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 National Fire Code of Canada requirements.

.9 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 Waste Management and Disposal.

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

.3 Collect and separate for disposal paper, plastic, polystyrene corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).

.4 Separate for recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan (WMP).

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal, regulations.

.7 Ensure emptied containers are sealed and stored safely.

.8 Unused paint, coating materials must be disposed of at official hazardous material collections site as approved by Departmental Representative.

.9 Paint, stain and wood preservative finishes and related materials (thinners and solvents) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.

.10 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.

.11 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.

.12 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:

.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.

.2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.

.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.

.4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.

.5 Empty paint cans are to be dry prior to disposal or recycling (where available).

.13 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

.14 Set aside and protect surplus and uncontaminated finish materials. Deliver to or arrange collection by organizations for verifiable re-use or re-manufacturing.

1.9 Site Conditions

.1 Heating, Ventilation and Lighting:

.1 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.

.2 Provide continuous ventilation for seven days after completion of application of paint.

.3 Coordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.

.4 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.

.5 Provide minimum lighting level of 323 Lux on surfaces to be painted.

.2 Temperature, Humidity and Substrate Moisture Content Levels:

.1 Unless pre-approved written approval by Paint Inspection Agency Authority and product manufacturer, perform no painting when:

.1 Ambient air and substrate temperatures are below 10 degrees C.

.2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.

.3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.

.4 The relative humidity is under 85% or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.

.5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

.6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.

.2 Perform painting work when maximum moisture content of the substrate is below:

.1 Allow new concrete and masonry to cure minimum of 28 days.

.2 15% for wood.

.3 12% for plaster and gypsum board.

.3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".

.4 Test concrete, masonry and plaster surfaces for alkalinity as required.

.3 Surface and Environmental Conditions:

.1 Apply paint finish 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 to adequately prepared surfaces and to surfaces within moisture limits.

.3 Apply paint when previous coat of paint is dry or adequately cured.

.4 Additional interior application requirements:

.1 Apply paint finishes 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.

1.10 Guarantee

.1 Furnish a 100% two (2) year Maintenance Bond.

.2 Painting and decorating Subcontractors providing a Maintenance Bond shall provide a maintenance bond consent from a reputable surety company licensed to do business in Canada.

.3 Cash or certified cheque are not acceptable in lieu of surety consent.

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 Provide paint materials for paint systems from single manufacturer.

.3 Only qualified products with E2 "Environmentally Friendly" rating are acceptable for use on this project.

.4 Conform to latest MPI requirements for interior painting work including preparation and priming.

.5 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.

.6 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.

.7 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:

.1 Water-based.

.2 Non-flammable.

.3 Manufactured without compounds which contribute to ozone depletion in the upper atmosphere.

.4 Manufactured without compounds which contribute to smog in the lower atmosphere.

.5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.

.8 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

.9 Flash point: 61.0 degrees C or greater for water-borne surface coatings and recycled water-borne surface coatings.

.10 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:

.1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.

.2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.

.11 Recycled water-borne surface coatings must not contain:

.1 Lead in excess of 600.0 ppm weight/weight total solids.

.2 Mercury in excess of 50.0ppm weight/weight total product.

.3 Cadmium in excess of 1.0ppm weight/weight total product.

.4 Hexavelant chromium in excess of 3.0 ppm weight/weight total product.

.5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

2.2 Colours

.1 Departmental Representative will provide Colour Schedule after Contract award. Submit proposed Colour Schedule to Departmental Representative for approval.

.2 Colour schedule will be based upon selection of five base colours and three accent colours. No more than eight colors will be selected for 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 restricted range of colours, selection will be based on limited range.

.5 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

.6 Refer to Colour Schedule of this Section, and Section 09 06 00 Finish Schedule and drawings for identification and location of colours.

2.3 Mixing and Tinting

.1 Perform colour tinting operations prior to delivery of paint to site. Obtain written approval from Departmental Representative for tinting of painting materials.

.2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

.3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.

.4 Thin paint for spraying in accordance with paint manufacturer's instructions.

.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 is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 Matte	Max.5	Max.10
Finish (flat) Gloss Level 2 -Velvet-Like Finish	Max.10	10 to 35
Gloss Level 3 -Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 -Satin-Like Finish	20 to 35	Min.35
Gloss Level 5 -Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 -Gloss finish	70 to 85	
Gloss Level 7 -High Gloss Finish	More than 85	

.2 Gloss level ratings of painted surfaces as indicated.

2.5 Interior Painting Systems – New Construction

.1 Concrete masonry units: smooth block:

.1 INT 4.2K – High Performance Architectural Latex (gloss level 3) finish.

.2 Gypsum Wall Board.

.1 INT 9.2B High Performance Architectural Latex (gloss level 3) Finish.

.3 All paint systems to be MPI Premium Grade 3 coat systems.

2.6 Interior Repainting Systems

.1 Concrete masonry units: smooth block.

.1 RIN 4.2K – High Performance Architectural Latex (gloss level 3) finish.

.2 Gypsum Wall Board.

.1 RIN 9.2B High Performance Architectural Latex (gloss level 3) finish.

.3 Shower room concrete ceiling

.1 Epoxy Coat: Sherwin Williams Macropoxy 646 or approved equal.

.4 All paint system to be MPI Premium Grade 3 Coat systems.

2.7 Source Quality Control

.1 Perform following tests on each batch of consolidated post-consumer material before surface coating is reformulated and canned. Testing by laboratory or facility which has been accredited by 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.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 General

.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 Examination

.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 properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". 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%.

.4 Wood: 15%.

3.4 Preparation

.1 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 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 passing pedestrians, building occupants and general public in and about the building.

.2 Surface Preparation in accordance with MPI Repainting Manual:

.1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.

.2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

.3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative.

.3 Clean and prepare surfaces in accordance with MPI Architectural 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 wiping with dry, clean cloths or compressed air.

.2 Wash surfaces with a biodegradable detergent 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. Minimize use of mineral spirits or organic solvents to clean up water-based paints.

.4 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.

.5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.

.1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.

.2 Apply wood filler to nail holes and cracks.

.3 Tint filler to match stains for stained woodwork.

.6 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.

.7 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 or vacuum cleaning.

.8 Touch up of shop primers with primer as specified.

.9 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.

3.5 Application

.1 Method of application to be as approved by Departmental Representative. Apply paint by brush, roller, air or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise.

.2 Brush and Roller Application:

.1 Apply paint in uniform layer using brush and/or roller type 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 free of roller tracking and heavy stipple.

.5 Remove runs, sags and brush marks from finished work and repaint.

.3 Spray application:

.1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.

.2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

.3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.

.4 Brush out immediately all runs and sags.

.5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.

.4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.

.5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.7 Sand and dust between coats to remove visible defects.

.8 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.

.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 Paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as indicated.

.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 Site Tolerances

.1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.

.2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.

.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.8 Field Quality Control

.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.

.4 Advise Departmental Representative when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

.5 Cooperate with inspection firm and provide access to areas of work.

.6 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.

3.9 Restoration

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and patter 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.

3.10 Paint Colour Schedule

.1 All metal doors / frames and metal handrails – medium grey (same as exterior).

.2 All concrete masonry units, expressed concrete ceiling, steel structure, steel joist, metal deck and gypsum wall board – white.

.3 All metal handrails and steel platform in pumphouse- to match existing.

END OF SECTION

Part 1 General

1.1 General

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

.2 The General Conditions, Supplements, Amendments and Mechanical General Requirements shall govern the plumbing sections of the work. Read in conjunction with the Instructions to Tenderers or Bidders.

.3 Provide domestic cold water, domestic hot water, sanitary drainage, sanitary venting, natural gas and all other piping, fixtures and equipment as specified below or as shown on the drawings.

.4 Plumbing drawings are diagrammatic and approximately to scale. They establish the scope of the plumbing work and the general location and orientation of the plumbing facilities. Plumbing facilities shall be installed generally in the locations and generally along the routings shown, close to the building structure with minimum interference with other services. Piping shall be concealed within walls, ceilings or other spaces and shall be routed to maximize head room and the intended use of the space through which they pass, unless specifically noted otherwise.

1.2 Related Work

.1 Electrical Division 26

1.3 Codes, Standards and Approvals

.1 Installation, workmanship and testing shall conform to the following standards:

.1 British Columbia Plumbing Code 2012

.2 Authority Having Jurisdiction

.3 ULC and FM Standards for applicable products

.4 CSA Standards for applicable products

1.4 Shop Drawings and Samples

.1 Submit shop drawings in accordance with Division 1.

.2 Shop drawings are required for:

.1 Pipe, fittings and couplings

.2 Valves

.3 Pumps

.4 Plumbing fixtures

.5 Water heaters, heat exchangers, storage tanks and expansion tanks

.6 Hydrants/hose bibs

.7 Floor drains and trap primers

.8 Cleanouts, access panels and access doors

.9 Water hammer arrestors

.10 Roof drains

.11 Sewage grinders, sewage pumps and controls

.12 Firestopping system and product data sheets

.13 Pipe insulation

.14 Pipe identification and valve tags

.15 Submit samples for:

.1 A 300 mm to 450 mm length of each type of pipe material for each system, both above ground and below ground.

.2 A 90 deg. fitting (and a coupling where applicable) for each type of material and for each type of piping system.

.3 Valves up to 50 mm [2"] nominal size.

.4 Pipe identification for each system, and two valve tags.

.16 All other system components and accessories

1.5 Maintenance Data

.1 Provide maintenance data summarized below for incorporation into the Mechanical Operating and Maintenance Manual.

.2 Include detailed instructions for the normal maintenance of all installed equipment including operational procedures, frequency of operational checks, service instructions and trouble shooting instructions.

.3 Local source of supply for each item of equipment indicating company, location, manufacturer's representative, phone number and e-mail address.

.4 Labeling and identification schedules.

.5 Valve schedule; including location, service type and normal valve position for all systems.

.6 Warranties, certificates and miscellaneous reports.

.7 Manufacturer's catalogue data sheets including a copy of the reviewed shop drawings of each component plus operating and maintenance brochures, including wiring diagrams.

.8 Comprehensive description of the operation of the system including the function of each item of equipment within the system.

.9 Operating electrical switchgear schedule indicating location of equipment.

.10 Lubrication schedule indicating the recommended lubricants and grades (grease or oil) for all lubricated equipment components.

.11 Test reports for all sections of piping.

1.6 Record Drawings

.1 Comply with requirements contained in Division 1.

.2 Maintain one set of contract drawing white prints, including all supplementary and revision drawings on site, solely for the purpose of recording, in red, any change and/or deviation from the Contract Drawings as it occurs.

.3 The set of white prints will be provided to the contractor by the Departmental Representative at the contractor's cost.

.4 The marked-up set of prints will be reviewed on site by the Departmental Representative during the construction process. This review may form a requirement for approval of the monthly progress claim.

.5 Backfilling shall not occur until underground services are surveyed.

.6 The Record Drawings shall include, but not limited to, the following changes and shall be recorded daily:

.1 Size, location, arrangement, routing and extent of piping, fixtures, drains, clean-outs, rough-in, etc. above and below grade inside and outside the building and including dimensioned locations of buried piping from building walls and gridlines.

.2 Location of back flow preventers.

.3 Location of water hammer arrestors.

.4 Location of trap primers.

.7 CAD Drafting:

.1 Refer to Section 23 05 93 for additional requirements to those listed below.

.2 Include all details from revision drawings, addenda, and change orders. Label each drawing in the lower right corner in letters of at least 12mm high as follows: "AS BUILT DRAWINGS", Contractor's name and date.

.3 Provide one set of check prints for review by the Departmental Representative.

.4 Upon review of the drawings by the Engineer, provide computer CAD files on a CD and two sets of hard copy plots.

1.7 Substantial Performance Requirements

.1 Before the Engineer is requested to make a field review for substantial performance of the work:

.1 Submit signed test forms for all sections of the piping.

.2 Submit completed marked up Record Drawings.

.3 Submit a letter on the Contractor's letterhead certifying that all work is complete.

1.8 Deficiency Holdbacks and Deficiency Field Reviews

.1 Work under this Division which is still outstanding when substantial performance is determined will be considered deficient and a sum equal to at least twice the estimated cost of completing that work will be held back.

.2 It is required that outstanding work be completed in an expeditious manner and the entire holdback sum may be retained until the requirements for Total Performance of Division 15 work have been met and verified.

1.9 Occupancy Requirements

.1 Before the Engineer is requested to submit their Schedule C-B as related to the occupancy permit, the contractor shall submit at least of the following documentation:

.1 All shop drawings.

.2 Backflow preventer test certificates.

.3 Piping system test certificates.

.4 Chlorination certificate.

.5 Firestopping certificate.

.6 Seismic engineer's Schedules B and C-B.

.7 Fire protection engineer's Schedules B and C-B.

.8 Mechanical maintenance manual.

.9 As-built drawings.

1.10 Connection Fees

.1 There are no municipal connection fees related to this project work.

1.11 Temporary Usage of Plumbing Systems and Equipment

.1 Plumbing systems and equipment shall not be used without the written permission of the Departmental Representative and in no circumstance shall be used prior to testing and inspection.

.2 Separate domestic water risers as indicated.

.3 Provide external domestic water heating heat exchangers, as indicated.

.4 Remove heating pipe bundles in existing tanks. Chlorinate and flush tanks before reconnecting them to the operational system. Note phasing requirements and maintain domestic water system operational at all times (cold and hot water).

.5 Provide new expansion tank with ancillaries, as indicated.

1.12 Chromium Plated Piping

.1 Use only strap wrenches on chromium plated pipe or fittings. Surfaces damaged by wrench marks shall be replaced. Joints shall be threaded or slip joints.

1.13 Acoustical Treatment

.1 General

.1 This project includes special acoustical requirements to ensure low noise levels in noise sensitive areas. The contractor shall in particular give careful consideration to equipment selection and pay close attention to detail during the rough-in stage in order to assure maximum acoustical benefit.

.2 The insulation for wall, ceilings and pipe chases as outlined herein is to be provided and installed under another division of work. This section is responsible for ensuring that all special requirements for plumbing systems have been met before the walls or ceilings have been closed in.

.2 General Scope of Work

.1 All plumbing systems located in any walls or within 2 metres [6½'] in any direction of the enclosing walls of the following areas (or of similar areas not specifically named) shall be especially protected against noise transmission as defined herein:

.1 Mechanical service spaces between cells.

.2 Mechanical attic services spaces above cells.

.3 Raised floor spaces in the Control Room.

.4 Ceiling spaces above offices.

.3 Summary of Requirements

.1 Drain, Waste and Vent Stacks and Rainwater Leaders:

.1 Cast iron pipe and mechanical joint fittings shall be used. Plastic, copper and aluminum DWV piping are unacceptable. Waste piping over sound sensitive areas shall be provided with a minimum 150 mm long section of minimum 12 mm thick 50 durometer closed cell neoprene

insulation, bearing on a minimum 150 mm long preformed galvanized steel load distribution shields at each pipe hanger.

.2 Waste connections from appliances and fixtures may be copper to the waste stack.

.3 All copper dry vent pipes in walls, chases and ceiling spaces shall be lagged with 25 mm [1"] preformed glass fiber pipe insulation, canvas wrapped and sealed airtight and with one or more coats of heavy enamel paint.

.4 Rainwater leader chases shall be airtight and contain non-compressed RSI 2.11 [R-12] glass fibre insulation where installed in the stud cavities.

.2 Domestic Water Operating Parameters:

.1 The maximum flow velocity in copper pipes in the supply and recirculating system shall be 1.5 metres [5 feet] per second for cold water and 1.2 metres [4 feet] per second for hot water.

.3 Pipe Sizes:

.1 The minimum pipe size to faucets or mixing valves of each fixture shall be 12 mm [½"]. The use of 9 mm [⅜"] pipes is strictly prohibited.

.4 Plumbing Fixtures and Trim:

.1 Back-to-back fixtures: Drain lines and water supply lines shall be individually connected to risers. Tee takeoffs serving back-to-back fixtures are not permitted.

.2 Quick Acting Valves: All flush valves, solenoid operated or other quick acting valves shall be equipped with water hammer arresters located as close to the valves as possible.

.5 Fastening to the structure:

.1 Piping shall not contact any concrete, concrete block, framing, stud or wall surface; or any other conduit, electrical fixture or ventilation duct that is connected to any wall or ceiling surface.

.2 Piping shall not be fastened to a partition which forms part of an adjacent room not served by the pipe in question. Do not secure piping to gypsum wallboard or its supporting frame.

.3 Riser clamps shall be isolated from the structure using an approved resilient material between the support collar and the floor structure (Vibro-Acoustics type SN, 30 durometer,

57 mm x 57 mm [2¼" x 2¼"] in size, or an approved equal). An alternate method is to wrap the pipe with neoprene prior to clamping.

.4 Pipe hangers shall be oversized to suit the insulation thickness and shall have a preformed galvanized steel load distribution shield between the insulation and the hanger.

.6 Clearance Around Pipes:

.1 All pipe (bare or insulated) shall be clear of contact with concrete, concrete block, studs or gypsum wallboard.

.2 Pipes in acoustically critical walls shall be wrapped with a minimum thickness of 6 mm [¼"] of Armaflex or Rubatex sleeving and secured by use of oversized clamps. This is not necessary where the piping is insulated provided that pipe clamps are mounted around the exterior of the insulation. Hard plastic pipe sleeves shall not be used.

.7 Wall and Slab Penetrations by Pipes:

.1 Pipes penetrating slabs or rated concrete or concrete block wall shall be mineral fiber wrapped prior to firestopping.

.2 Gypsum wallboard or plaster wall pipe penetrations shall be 3 mm [⅛"] to 6 mm [¼"] oversized with the pipe centred in the hole and the gap caulked with silicone or other non-hardening sealant for unrated separations, and firestopping for rated separations.

.3 Pipe expansion joints shall be for noise free operation.

.8 Ceiling, Wall and other Plumbing Pipe Chases:

.1 The interior spaces shall be insulated with non-compressed RSI 2.11 [R- 12] batt insulation in the following proportions:

.1 Ceiling plenum - 80% of area.

.2 Chases - 100% of all four vertical surfaces.

.3 Walls - 50% of space containing pipe, and 100% of adjacent stud space.

1.14 Cold Weather Protection

.1 Roof penetrations:

.1 All vent penetrations of the roof structure shall be 100 mm [4"] minimum size.

.2 Hose bibs:

.1 All exterior hose bibs shall be non-freeze type complete with a self draining vacuum breaker.

1.15 Seismic Protection

.1 Supply and install sway-bracing hangers on the following systems:

.2 This shall apply to all cross-mains including loops, 50 mm [2"] and larger, and shall apply to feed mains including risers. Horizontal piping shall be 2-way bracing and vertical piping shall include 4-way bracing at the tops of the risers. Spacing of horizontal 2-way sway braces shall not exceed 12 metres [40']. On floor loops sway-braces are also required at the corners of the loops.

.3 Restraints shall meet the requirements of the National Building Code of Canada 2005.

.4 Arrange and pay for the services of a B.C. Registered Professional Engineer. This seismic engineer shall provide all required engineering services related to seismic restraints of non-vibration isolated plumbing equipment and piping. The seismic engineer shall provide assistance to the contractor as necessary during the course of restraint of equipment and piping. The seismic engineer shall provide field reviews of the work during construction and the completed seismic installation.

.5 Submit signed and sealed Schedules B-1 and B-2 to the Engineer at the beginning of the project and Schedule C-B at completion of the project, a minimum of 10 working days prior to Occupancy.

1.16 Building Operation during Construction

.1 In order to minimize operational difficulties for the existing building and the staff, the Contractor must cooperate with the Departmental Representative throughout the entire construction period and particularly ensure that noise is minimized.

.2 Minor inconvenience and interruption of services will be tolerated, provided advance notice is given to the Departmental Representative, but the Contractor will be expected to coordinate their work, in consultation with the Departmental Representative, so the operation of the existing facility can be maintained as nearly normal as possible.

1.17 Existing Services

.1 Protect all existing services encountered and be responsible for any damages to existing systems by the work of this contract. Obtain instructions from the Departmental Representative when existing services require relocation or modifications, other than those already indicated in the Contract Documents.

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

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

.4 The Departmental Representative reserves the right to withhold permission for a reasonable period with respect to any shutdown, if the shutting off of a service will interfere with important operations.

1.18 Connection to Existing Systems on this Site

.1 These documents include work that will require connections of piping systems to existing systems including the water connection within the existing pump house building, the sanitary connection at the existing sewage treatment plant, and the natural gas connection at the existing gas meter station.

.2 Provide all necessary excavation, coring, piping adjustments and offsets as required to connect to those services. Report any major discrepancies to the Departmental Representative.

.3 Cooperation with respect to on-site coordination of all piping connections is an integral part of the responsibility of this section of the work all within the basic tender price. No extra cost will be allowed based on a failure to allow for scheduling and coordination of piping connections to produce a complete workable system whether shown on the drawings or not.

.4 Coordinate with the gas utility company for tie-in at the gas meter station. Provide a lamicoid label on the main isolation valve to the new building labeled in accordance with the requirements of the Departmental Representative.

.5 The contractor shall visit the site prior to submitting their tender.

1.19 Building Management System (BMS)

.1 Refer to and coordinate with the HVAC and controls subcontractors.

.2 The following equipment and systems shall include contacts and/or electronic relays as required as an integral part of the equipment supplied and installed in the Plumbing Section of the work to allow connection from such equipment to a BMS Building Management System computer terminal in a location remote from each plumbing system location.

.3 The plumbing systems to be monitored and/or controlled on the BMS system are as follows:

.1 Domestic hot water recirculation pumps.

.2 Domestic hot water temperature sensor.

.3 Solenoid valve at the Dry Cell.

.4 Solenoid valve at the expansion tank.

.4 The plumbing contractor shall install temperature wells at pipe locations to be determined by the BMS controls contractor. Temperature sensors are provided and connected by the BMS controls contractor.

.5 Connections from plumbing systems to BMS are by the BMS controls contractor

1.20 Firestopping

.1 Provide firestopping for all plumbing penetrations of rated separations to CAN4 S-115.

Part 2 Products

2.1 General

.1 All materials shall be new and of the condition as originally manufactured free of defects.

2.2 Non-security Access Doors

.1 Non-security access doors shall only be used in Administration Areas.

.2 Design:

.1 Plaster or wet wall construction: 1.70 mm [14 gauge] thick bonderized steel flush with wall or ceiling type with concealed flange. - Acceptable Materials: Acudor PS-5030, or equivalent.

.2 Masonry or drywall construction: 1.35 mm [16 gauge] thick for 400 mm [16"] x 400 mm [16"] and smaller, 1.70 mm [14 gauge] thick for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange. - Acceptable Materials: Acudor UF-5000, or equivalent.

.3 Water resistant finished walls, tile, ceramic tile, water resistant dry wall, plaster or wet wall construction in washrooms and other special areas: 1.80 mm [14 gauge] thick stainless steel flush with wall or ceiling type with concealed flange. - Acceptable Materials: Acudor PS-5030 stainless, or equivalent.

.4 Acoustical tile ceiling and similar block materials: 1.70 mm [14 gauge] thick bonderized steel recessed ceiling type. - Acceptable Materials: Acudor AP-5010 or AT-5020, or equivalent.

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

.3 Minimum Requirements:

.1 Materials:

.1 Concealed hinges.

.2 Adjustable anchoring straps or lugs to suit construction.

.2 Finish:

.1 Prime coat bonderized steel types.

.2 Brushed stainless steel for stainless steel types.

.3 Size:

.1 300 mm x 300 mm [12" x 12"] for cleanout or hand access.

.2 600 mm x 600 mm [24" x 24"] for entry access

.4 Locking devices:

.1 Screwdriver cam locks.

.2 Allan key cam locks

.5 Access panels in fire separations and fire walls shall have a compatible fire rating and ULC label (i.e., Acudor Fire Rated FW-5050 or FB-5060, or equivalent).

.6 Submit shop drawings.

.7 Supply and locate all access doors under this section of work. Installation shall be by the General Contractor or their designated other subtrades.

.4 Acceptable Materials: Acudor, Can-Aqua, Mifab, Milcor, Nystrom, Van-Met, or equivalent.

2.3 Security Access Doors

.1 Refer to architectural sections of the specifications for security access doors in all inmate areas.

.2 The plumbing contractor shall clearly identify on site all required locations and sizes of security access doors in a timely manner as work progresses.

.3 Work in conjunction with the concrete block trades, ceiling trades and other related trades.

2.4 Cleanouts

.1 Cleanouts shall be full size for pipe sizes up to 100 mm [4"] and not less than 100 mm [4"] on larger sizes. Cleanouts in inside finished areas shall all be round.

.2 Cleanouts passing through a waterproofed floor or a slab on grade subject to hydrostatic pressure shall possess a clamping collar which shall be clamped to the floor membrane or lead flashing. Refer to Section 15401, 'Safes, Flashings and Vent Terminals'.

.3 Pipe manufacturers' cleanouts are acceptable for vertical installation at the base of soil and waste stacks or rainwater leaders only.

.4 Make cleanouts with a Barrett type fitting that has a bolted coverplate and gasket, fittings that have a threaded plug, or a cleanout ferrule that is installed in a wye or extended wye.

.5 Outside area cleanouts shall be of heavy duty construction. - Acceptable Materials: Zurn Z1400, Jay R. Smith, Ancon, Mifab, or equivalent.

.6 Unfinished concrete area cleanouts shall be of heavy duty construction and have a fully exposed scoriated cover. - Acceptable Materials: Zurn Z1400, Jay R. Smith, Ancon, Mifab, or equivalent.

.7 Lino or lino tiled area cleanouts shall have the centre portion of cover recessed to receive a piece of tile that matches the adjoining tile. - Acceptable Materials: Zurn ZN 1400-X or ZN 1400-TX, Jay R. Smith, Ancon, Mifab, or equivalent.

.8 Ceramic tile floor area cleanouts shall have a fully exposed scoriated cover. - Acceptable Materials: Zurn ZN 1400 or ZN 1400-T, Jay R. Smith, Ancon, Mifab, or equivalent.

.9 Carpet area cleanouts shall be fully concealed with a small raised marker. - Acceptable Materials: Zurn ZN 1400-CM, Jay R. Smith, Ancon, Mifab, or equivalent.

2.5 Hangers and Supports

.1 Hanger Supports:

.1 Carbon steel construction.

.2 Adjustable for proper grading.

.3 Rods shall be cadmium plated with continuous thread in accordance with ANSI B-31. - Acceptable Materials: Grinnell Fig 146, Myatt Fig 434, or equivalent.

.4 Hanger types:

.1 Up to 25 mm [1"]. - Acceptable Materials: Grinnell Fig 269, Myatt Fig 120, or equivalent.

.2 2 30 mm [1¼"] and larger. - Acceptable Materials: Grinnell Fig 260 or 65, Myatt Fig 122 or 124, or equivalent.

.3 Hangers for metallic non-ferrous pipe shall be plated and plastic dipped or the pipe shall be wrapped for a minimum 150 mm length centered on the hanger with Polyken tape.

.2 Wall Supports:

.1 Horizontal pipes adjacent to walls: Angle iron wall brackets with specified hangers.

.2 Vertical pipes adjacent to walls:

.1 Exposed pipe wall guide. - Acceptable Materials: Grinnell Fig 235 or 236, or equivalent.

.2 Channel type supports. - Acceptable Materials: Brundy, Canadian Strut, Cantress Unistrut, or equivalent.

.3 Floor Supports:

.1 Vertical pipe.

.1 Risers where they pass through floors shall be standard riser clamps. - Acceptable Materials: Grinnell Fig 261 or Myatt Fig 182 (Grinnell Fig CT-121 for copper pipe), or equivalent.

.2 Base of risers where they are adjacent to and above floor slabs shall be adjustable fabricated steel floor supports.

.3 Provide load bearing plates below riser clamps c/w factory mounted neoprene rubber to minimize noise transmission.

.4 Inserts, Anchors and Beam Clamps:

.1 Select for the application and load.

.2 Do not use explosive type inserts unless permitted by the structural Engineer.

2.6 Pipe Sleeves and Escutcheons

.1 Non-combustible pipe penetrations through fire separations that are required to have a fire resistance rating shall be firestopped to ULC/CAN4 S-115.

.2 Combustible pipe penetrations through fire separations that are required to have a fire resistance rating shall be as follows:

.1 Intumescent firestopping material contained in a metal housing that is certified per ULC/CAN4 S-115 for firestopping use. Installation shall be implemented in full compliance with the certified installation procedures. - Acceptable Materials: FGC Fireguard Corp. DONUT Firestop for flat surfaces; 3M Brand (Intumescent) Fire Barrier, Dow Corning Fire Stop Intumescent Wrap for Q- deck, or equivalent.

.3 Pipe penetrations through separations that are not required to have a fire resistance rating shall be as follows:

.1 Interior concrete or block wall sleeves and floor slab sleeves in dry areas shall be steel pipe or removable plastic pipe and sealed with silicone.

.2 Floor slab sleeves in wet areas, outside wall sleeves and roof slab sleeves shall be steel pipe and sealed with silicone.

2.7 Miscellaneous Metal Related to Plumbing Systems

.1 Frames shall be of welded construction consisting of angle iron sections with 8 mm [5/16"] locating strips and anchoring lugs at a minimum of 900 mm [36"] centres.

.2 Backing Plates shall be adequate to support the use intended and shall be a minimum 4.8 mm [3/16"] in thickness.

2.8 Pipe Bedding

.1 All buried piping inside the building below floors and slabs, shall be supported on a bed of well compacted sand (i.e., 95% Modified Proctor Density). Bedding shall extend from 150 mm [6"] below the pipe and shall support the pipe barrel, not the joints and/or couplings. Before backfilling, the complete line shall be inspected and approved by the authorities having jurisdiction.

2.9 Sanitary Waste Piping

.1 Install minimum 150 mm [6”] diameter sanitary piping from all water closets.

.2 Minimum 1.5% slope on all sanitary piping.

.3 Install offsets in nominally horizontal pipe utilizing a 1 meter long section of pipe between successive 45 degree changes of direction, to minimize blockages. Do not install a wye and 45 degree fitting or two 45 degree fittings in close succession.

.4 Install cleanouts generally in secured areas.

Part 3 Execution

3.1 Piping Installation

.1 General:

.1 Install piping straight, parallel and close to walls and ceilings.

.2 Install piping with a slope of not less than 1.5% for gravity piping below grade, not less than 1% for all other gravity piping 100 mm and larger, and not less than 2% for all other gravity piping 75 mm and smaller.

.3 Provide a slope to drain cocks, fixtures or equipment for all water supply and pressure piping unless otherwise indicated on drawings.

.4 Install groups of piping parallel to each other; spaced to permit application of insulation, identification, and service access, on trapeze hangers.

.5 Where sizes differ from pipe sizes to equipment connection sizes, install reducing fittings close to the equipment. Reducing bushings are not permitted.

.6 Brass and copper pipe and tubing shall be free from surface damage. Replace damaged pipe or tubing.

.7 Ream ends of pipe and tubes before installation.

.8 Lay copper pipe and tubing so that it is not in contact with dissimilar metal or in direct contact with concrete, and will not be crimped or collapsed.

.9 All joints on cast or ductile iron pressure service piping shall be made electrically conductive.

.10 Install flanges or unions to permit removal of equipment and serviceable components without disturbing piping systems.

.11 Clean the ends of pipes or tubing and the recesses of fittings to be jointed. Assemble joints without binding.

.12 Install piping to connections at fixtures, equipment, outlets and all other appurtenances requiring service. Trap and vent waste connections to fixtures. Grade all vents to drain back to waste piping.

.13 Plug or cap pipe and fittings to keep out debris during construction.

.14 Jointing of pipe shall be compatible with type of pipe used.

.15 Non-corrosive lubricant or teflon tape shall be applied to the male thread of threaded joints.

.16 Flush and clean out piping systems after testing.

.2 Equipment Drainage:

.1 Install drain valves at low points.

.2 Extend equipment drain piping to discharge into floor or hub drains.

.3 Expansion and Contraction:

.1 Support piping to prevent any stress or strain.

.2 Install pressure piping with loops and offsets which will permit expansion and contraction to occur without damaging the pressure piping system.

.4 Buried Piping:

.1 Lay pipe on compacted bedding of clean, coarse sand free from clay, snow, ice, organic matter or stones.

.2 Do not lay pipe in water or when conditions are unsuitable.

.3 Comply with Worker's Compensation Board requirements regarding safety and working conditions.

3.2 Access Doors

.1 Install access doors at all concealed cleanouts, traps, unions, expansion joints, valves, control valves, air vents, water hammer arrestors, trap primers, vacuum breakers and any other equipment for which subsequent periodic access will be required during the life of said equipment or components.

.2 Locate access doors so that all concealed items are readily accessible for adjustment, operation, maintenance and replacement.

.3 Do not locate access doors in inmate areas, feature walls or ceilings or at the high spaces without the prior approval of the Engineer. Extend

piping and components over and locate in service areas and storage rooms wherever possible.

3.3 Cleanouts

.1 Install cleanouts at the following locations:

.1 Building drain leaving the building on the downstream side of the exterior wall.

.2 Changes of direction of more than 45 degrees in drainage piping.

.3 Nominally horizontal branches or building drains at intervals of not more than 7.5 metres [25'] for pipe sizes 65 mm [2½"] and less, 15 metres [50'] for 75 mm [3"] and 100 mm [4"] pipe sizes, and 26 metres [85'] for pipe sizes larger than 100 mm [4"].

.4 Fixture drains from kitchen sink piping at intervals not exceeding 7.5 metres [25'] for pipe all sizes.

.5 Base of soil or waste stacks and rainwater leaders, both interior and exterior.

.6 As called for by the B.C. Plumbing Code 2006.

.2 Install cleanouts which are located low on walls at 75 mm [3"] minimum above the top of the baseboard or minimum 200 mm [8"] above finished floor level where there is no baseboard.

.3 Cleanouts shall be coordinated with all millwork and with all other obstructions, shall be placed in readily accessible locations and shall have sufficient clearance for rodding and cleaning.

.4 Extend cleanouts to the finished floor or wall unless exposed in a basement room or ceiling space.

.5 Cleanouts in wet floor areas shall extend above the floor in walls or be provided with gasketted waterproofed tops.

.6 Cleanouts on outside drains shall be brought to grade and anchored in a concrete collar.

3.4 Hangers and Supports

.1 On insulated piping larger than 25 mm [1"] diameter where the insulation possesses a continuous vapour barrier, install oversized hangers and insulation protection shields of thickness and length as recommended by the manufacturer. On insulated piping 25 mm [1"] diameter and less protect contact between pipe and hanger and fit insulation tightly around hanger rod penetration through insulation.

.2 Maximum hanger spacing: (maximum spacing for cast or ductile iron is 1.5 metres [5']).

Pipe Size Mm	Rod Dia. Mm	Steel m [ft.]	Copper m	PVC
To 18 [¾]	9 [⅜]	1.5 [5]	1.5 [5]	1.05 [3½]
25-30 [1-1¼]	9 [⅜]	2.1 [7]	1.8 [6]	1.2 [4]
40-50 [1½-2]	9 [⅜]	2.7 [9]	2.4 [8]	1.2 [4]
65-75 [2½-3]	12 [½]	3.3 [11]	3.0 [10]	1.2 [4]
100-125 [4-5]	15 [⅝]	4.2 [14]	3.6 [12]	1.2 [4]
150 [6]	20 [¾]	5.2 [17]	1.2 [4]	
200-250 [8-10]	22 [⅞]	5.8 [19]	1.2 [4]	

.3 Do not support horizontal piping runs from the floor unless specifically indicated.

3.5 Pipe Sleeves and Escutcheons

.1 Sleeves shall be concentric with the pipe and shall be sized to allow for the continuity of insulation.

.2 Extend sleeves 50 mm [2"] above floor slabs in wet areas. Wet areas include equipment rooms, janitor's rooms, utility rooms and plumbing service chases.

.3 Extend sleeves through outside walls to 12 mm [1/2"] beyond the exterior face and caulk with flexible caulking compound.

.4 Where removable plastic sleeves are used they shall be removed prior to pipe penetration and the resulting hole shall be then classified as the sleeve.

.5 Install chrome plated escutcheon plates on exposed piping passing through walls, floors and ceilings in finished areas.

3.6 Core Drilling and Cutting

.1 The work of this contract shall include for all required coring to accommodate the plumbing works, where sleeves have not been provided in a timely manner.

.2 Arrange and pay for the cost of all core drilling and cutting for plumbing systems in this section of the work.

.3 Coring and cutting of structural building components shall only take place upon the receipt of specific written approval of the structural engineer. Repairs to existing services damaged as a result of core drilling is included in this section of the work.

.4 Penetrations up to 150 mm [6"] nominal pipe size in precast concrete may be cored on site. Larger penetrations shall be located and arranged for in precast work with precast manufacturer prior to shipping to construction site.

3.7 Miscellaneous Works Relating to Plumbing Systems

.1 All miscellaneous metal related to the plumbing systems including, all metal back up plates and supports for all ceiling or wall supported equipment or plumbing fixtures, all steel covers or cages to protect exposed piping subject to mechanical damage is part of this section of the work.

.2 Prime coat after fabrication with two coats of red primer.

.3 See separate division of specification for finish painting requirements.

.4 Provide blocking at all fixture stops and anchor the supply lines using dog ear elbows.

3.8 Piping Expansion

.1 All piping systems, including all take-offs shall be so installed within the building that the piping and connected equipment will not be distorted by expansion, contraction or settling.

.2 If circumstances on the job require additional changes in direction from those shown on the drawings, the configuration shall be adjusted to suit at no extra cost.

.3 Anchors shall be installed where necessary to control expansion. Expansion joints or loops shall be installed on hot water supply and recirculation piping where required.

3.9 Natural Gas Systems

.1 Provide new isolation valves on gas connections to minimize shutdowns during phased removal and installation of the boilers.

.2 Reconnect new boilers to existing gas supply.

3.10 Testing and Inspection

.1 Note phasing requirements for the project. Coordinate all work and timing with General Contractor.

.2 Give written 72 hour notice to the Departmental Representative of dates for tests.

.3 Do not conceal work until tested and reviewed. Follow the construction schedule and arrange for tests.

.4 Conduct tests in the presence of the Departmental Representative or their representative. Arrange for the Departmental Representative to be present at their discretion.

.5 Bear all costs for testing including retesting and making good.

.6 Provide notification to the Authority Having Jurisdiction and ensure work is reviewed by the in accordance with their requirements prior to backfilling.

.7 Test all sanitary waste and storm drainage piping systems with hydraulic pressure of 1500 mm to 3000 mm for 8 hours.

.8 An air test may be used during freezing conditions where permitted by the Authority Having Jurisdiction.

.9 Provide copies of written reports for all sections of the work as it is tested, and retain a copy of all test reports on site.

.10 Furnish all labour, materials, instruments, etc. necessary for all required tests.

.11 All leaks shall be corrected by remaking the joints. The systems shall be retested until no leaks are observed.

.12 If any plumbing system or part thereof is covered before being inspected or approved, it shall be uncovered upon the direction of the Authority Having Jurisdiction, and/or Departmental Representative at no additional cost to the Departmental Representative.

END OF SECTION

Part 1 General

1.1 Related Work

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

1.2 Scope of Work

.1 Domestic water systems include domestic cold water, domestic hot water and domestic hot water re-circulation systems.

.2 Domestic water piping shall be provided as depicted on the drawings to all plumbing fixtures, appliances and equipment that require domestic water service.

.3 Work includes relocating tanks and providing new tanks where noted.

.4 Mechanical make-up water piping for HVAC systems and force main or pressure waste water piping systems shall be constructed of materials, installed and tested as specified in this section of the work.

1.3 Cross Connection Control

.1 All installations shall be in accordance with the recommendations contained in the latest edition of the Cross-Connection Control Manual published by Pacific Northwest Section of the American Water Works Association.

.2 Double check valve assemblies and reduced pressure principle backflow prevention devices shall have approval from the Foundation for Cross Connection Control, University of Southern California, and from the City of Vancouver.

.3 Vacuum breakers shall conform to the requirements of C.S.A. B64.5.

.4 Following installation, a test report completed by a certified tester shall be submitted to the Departmental representative, indicating satisfactory operation of each device.

.5 Tests are to be conducted in the period 30 to 60 days prior to date of Substantial Completion.

.6 Provide one repair kit for every cross-connection control device installed.

.7 Copies of test forms are to be included in each Maintenance Manual.

Part 2 Products

2.1 Pipe and Fittings

.1 Buried water pipe and fittings inside the building:

.1 100 mm and smaller.

.1 Type 'K' seamless soft copper tubing to ASTM B88 or copper pipe to ASTM B42 with cast brass or wrought copper

fittings and silver soldered joints all encased in a polyethylene piping system.

.2 100 mm and larger.

.1 Centrifugally spun cement lined cast iron pipe with rubber ring type joints for 1380 kPa working pressure.

.2 Ductile iron cement lined Class 50 or 52 pipe with rubber ring, or mechanical type joints for 1380 kPa working pressure to AWWA C151.

.3 Cast iron fittings with rubber ring or mechanical type joints for 1380 kPa working pressure.

.4 All fittings shall be provided with integral tie lugs. Weld on lugs are not acceptable.

.5 Tie rods, bolts and nuts shall conform to the requirements of ASTM specifications for steel bridges and buildings, serial designation A-7. All bolts shall have American Standard course screw threads with a Class 2 free fit, or equivalent. Rolled threads are unacceptable.

.2 Above ground water pipe inside the building:

.1 Ductile iron pipe to AWWA C151 for cut grooved fittings. Ductile iron pressure couplings to ANSI/AWWA C-606 for cut grooved ductile iron pressure pipe with synthetic rubber gasket, plated carbon steel bolts, alkyd phenolic primer and protective enamel finish.

.2 Acceptable Product: Victaulic Style 31 Couplings and Style 307 Transition Couplings, or equivalent.

.3 Type 'K' hard drawn seamless copper tubing to ASTM B88 or copper pipe to ASTM B42. All type 'L' copper water tubing shall be certified by the Canadian Standards Association or Warnock Hersey Professional Services Ltd. to ASTM B88.

.3 Above ground copper water pipe fittings inside the building:

.1 Use of the 'T-Drill' system of joining copper piping is not acceptable.

.2 Cast brass or wrought copper solder joint pressure fittings with 95/5 Sn/Sb or Silvabrite 100 solder joints.

.3 Cast bronze or wrought copper roll grooved pressure fittings with grooved mechanical pipe connector couplings, complete with angle bolt pads to provide a rigid joint with Victaulic 'Flush Seal Gaskets', or equivalent.

.4 Acceptable Products:

.1 Victaulic 'The Copper Connection System for Copper Tubing (CTS)' with 606 couplings, 600 series fittings, 641 flange adaptors and 608 BFV, or equivalent.

.5 Exception: Where compression fittings are required they shall be to ANSI B16.22-1973.

2.2 Valves

.1 Gate: (for shut-off and isolation)

.1 50 mm and smaller, bronze body, solid wedge disc, bronze or stainless steel trim, non-rising stem, 860 kPa rating.

.2 Acceptable Products:

.1 Solder joint type: Crane 1320, Grinnell 3000SJ, Grinnell Powell 1822, Jenkins 300P, Kitz 41, Red & White / Toyo 281A, or equivalent.

.2 Threaded joint type: Crane 428, Jenkins 810, Kitz 40, Red & White / Toyo 280A, or equivalent.

.3 65 mm and larger, flanged ends, cast iron body, solid wedge disc, bronze or stainless steel trim, rising stem, outside screw and yoke.

.4 Acceptable Products: Crane 465-1/2, Jenkins 404, Kitz 72, Red & White / Toyo 421A, or equivalent.

.2 Ball: (in lieu of gate valves or as specified)

.1 50 mm and smaller, brass two piece body, blow-out proof stem, PTFE seats, brass chrome plate ball, lever handle operator, 1035 kPa rating.

.2 Acceptable Products:

.1 Solder joint type: Red & White / Toyo 5049A, Apollo 70-100, Crane, Jenkins, Kitz 59, or equivalent.

.2 Threaded joint type: Red & White / Toyo 5044A, Apollo-70-200 Series, Crane 93-TF, Jenkins-1101-T, Kitz 58, or equivalent.

.3 Butterfly: (in lieu of gate valves or as specified)

.1 65 mm and larger, 1,380 kPa rating, wafer style or threaded lug style cast iron body, EPDM seat liner, bronze disc, 403 stainless steel stem, 10 position lever lock handle operator on 150 mm diameter and smaller, handwheel worm gear operator on 200 mm diameter and larger, for installation between Class 125 / 150 flanges.

.2 Acceptable Products:

.1 Wafer style: Apollo 141, Center Line L200W/G200W (EPDM), or equivalent.

.3 Lug style: Apollo 143, Center Line L200L/G200L (EPDM), or equivalent.

.4 In grooved end copper pipe systems use Victaulic Style #608 bronze body grooved end valve c/w EPDM encapsulated disc, rated to 2067 kPa (300 psi), or equivalent.

.5 In grooved end ductile iron pipe systems use Victaulic Style #300 PPS coated grooved end BFV c/w EPDM encapsulated disc rated to 2067 kPa (300 psi), or equivalent.

.4 Globe: (for throttling, bypass and make-up applications)

.1 50 mm and smaller, bronze body, bronze or stainless steel trim, 860 kPa rating.

.2 Acceptable Products:

.1 Solder joint type with bronze bevel type disc: Crane 1320, Jenkins 300P, Kitz 10, Red & White / Toyo 212, or equivalent.

.2 Threaded joint type with composition type disc: Crane 7, Jenkins 106A, Kitz 03, Red & White / Toyo 220, or equivalent.

.3 65 mm and larger, flanged ends, cast iron body, bronze or cast iron bevel-type disc, bronze or stainless steel trim, rising stem, outside screw and yoke. Acceptable Products: Crane 351, Jenkins 2342, Kitz 76, Red & White / Toyo 400A, or equivalent.

.5 Check: (for horizontal installation)

.1 50 mm and smaller, threaded joint type, bronze body, bronze or stainless steel swing disc holder with Teflon disc, 860 kPa rating, or equivalent.

.2 Acceptable Products: Crane 37, Jenkins 4092, Kitz 22, Red & White / Toyo 236, or equivalent.

.3 65 mm and larger, flanged ends, cast iron body, bronze or cast iron swing disc, bronze or stainless steel trim, 860 kPa rating, or equivalent.

.4 Acceptable Products: Crane 373, Jenkins 587, Kitz 78, Red & White / Toyo 435A, or equivalent.

.5 In grooved end ductile iron pipe systems use Victaulic Style #717 PPS coated valves c/w EPDM encapsulated disc rated to 2067 kPa (300 psi), or equivalent.

.6 Balance: (for domestic hot water and tempered water recirculation)

.1 Tour & Anderson circuit balancing valve with dial indicator and measuring ports, or equivalent.

.7 Vacuum relief: (for hot water tank installations)

.1 Up to 12 mm, 860 kPa rating.
Acceptable Products: 12 mm Watts 36A, Cash Acme, or equivalent.

.2 12 mm and larger, 860 kPa rating.
Acceptable Products: 18 mm Watts 36A, Cash Acme, or equivalent.

.8 Pressure reducing valve with integral low flow bypass:

.1 65 mm and larger, 860 kPa rating.
Acceptable Products: Watts PV-10-06M, Clayton, Singer, Wilkins, or equivalent.

.9 Drain Valves and Interior Hose Bibbs:

.1 Interior Hose Bibbs: Lockshield globe type with bronze body and trim suitable for maximum system operating pressure.
Acceptable Products: Dahl 2316, or equivalent.

.2 Drain Valves: Ball type with brass body, cap & chain and chrome plated brass ball.
Acceptable Products: Kitz 58CC, Red & White / Toyo 5046, Dahl, or equivalent.

.3 Stop and Drain Valves: Emco 10151, or equivalent.

.10 Solenoid:

.1 Slow closing solenoid valve, forged brass body, Buna "N" disc, stainless steel parts, enclosure to suit environmental conditions, ULC and CSA approved, 120 volt.

.2 Acceptable Products: ASCO, or equivalent.

2.3 Vacuum Breakers

.1 Pressure type:

.1 CSA approved, mechanically independent spring loaded poppet type check valve with a down stream spring loaded air inlet valve, with upstream and downstream isolation valves and test cocks.

.2 Acceptable Products: Cla-Val, Conbraco, Febco, Watts, Wilkins, or equivalent.

.2 Atmospheric type:

.1 CSA approved, bronze body, chrome plated finish where exposed.

.2 Acceptable Products: Conbraco, Febco, Watts, Wilkins, or equivalent.

.3 All vacuum breakers shall be sized in accordance with the following table:

Pipe Size mm	Pressure Type Size mm	Atmospheric Type Size
12 - 25	12	Full Pipe Size
30 - 40	19	Full Pipe Size
50 - 75	25	Full Pipe Size

2.4 Backflow Prevention Stations

.1 Double check valve assembly (DCVA), factory assembled station to CSA B64.5.

.2 Acceptable Products: Watts Series 709; Ames, Cla-Val, Conbraco, Febco, Wilkins, or equivalent.

.3 Reduced pressure backflow prevention device (RPBP Standards of Acceptance: Metraflex MetraSeal; Link Seal.), with inlet and outlet shut-off valves, double check valve assembly, differential relief outlet and repair/maintenance kit to CSA B64.10- M1984.

.4 Acceptable Products: Watts Series 909; Ames, Cla-Val, Conbraco, Febco, Wilkins, or equivalent.

2.5 Strainers

.1 Sized on a 4 to 1 ratio of basket open area to connecting pipe cross-sectional area, 'Y' pattern, 304 stainless steel screen.

.2 6 mm to 50 mm threaded ends, bronze body, 1034 kPa rating.

.3 Acceptable Products: Red & White / Toyo 380, Crane 988-1/2, Armstrong, Sarco (Canada), Kitz 15, or equivalent.

.4 65 mm and larger, flanged ends, cast iron body, 860 kPa rating.

.5 Acceptable Products: Red & White / Toyo 381A, RP&C 531, Crane 989-1/2, Armstrong, Sarco (Canada), Kitz 80, or equivalent.

.6 In grooved end ductile iron piping systems use Victaulic Style #732 PPS coated Wye strainer rated to 2067 kPa (300 psi).

2.6 Pressure Gauges

.1 Design Basis:

.1 Pipe mounting type, plain case style, bottom connection.

.2 Wall or panel surface mounting type, flanged type.

.3 Flush panel mounting type, flush mount case style.

.2 Minimum Requirements:

.1 Seamless phosphor bronze Bourdon tube type, with minimum 115 mm diameter dial, unless otherwise indicated.

.2 Cast aluminum, black steel or stainless steel case, with stainless steel or chrome plated face ring.

.3 White background with pressure range in black.

.4 Accuracy - 2% of scale range.

.5 Scales to be calibrated in both psig and kilopascals.

.6 Scale range: for operating pressures of 0 - 1,035 kPa the scale range shall be 0 - 2,000 kPa

.3 Install a needle valve ahead of each gauge.

.4 Acceptable Products: Terice, Weiss, Weksler, or equivalent.

2.7 Water Hammer Arrestors

.1 Bellows or piston manufactured style with stainless steel casing and welded stainless steel nesting bellows if of the bellows style. Air chambers are unacceptable.

.2 Acceptable Products: Zurn Z-1700 Series bellows style, Jay R. Smith, Ancon, Amtrol, Watts; Precision Plumbing Products Inc. piston style, or equivalent.

.3 Provide snubbers on all gauges mounted within 1 meter of a pump

2.8 Thermometers

.1 Minimum Requirements:

.1 Pipe mounted stem type - Mercury actuated, straight or angle pattern up to 2 metres above floor.

.2 Pipe mounted stem type - Mercury actuated adjustable angle over 2 metres above floor.

.3 Pipe mounted dial type - Solid liquid filled with remote capillary element.

.4 Panel mounted dial type (flush) type - remote liquid filled capillary element.

.2 Cases:

.1 Stem type - cast aluminum (protected glass type).

.2 Dial type - cast aluminum, black enamel steel or stainless steel with stainless steel or chrome-plated face ring.

.3 Scale:

.1 Stem type - 150 mm scale length up to 2 metres above floor, 225 mm scale length over 2 metres above floor unless otherwise indicated.

.2 Dial type - nominal 115 mm dial unless otherwise indicated.

.3 White background with temperature range in black.

.4 Temperatures shall be indicated in degrees Celsius (Fahrenheit).

.4 Select thermometers so that their operating range falls in the middle half of the scale range, wherever possible.

.5 Provide stainless steel or brass thermometer wells in the piping to receive thermometers, complete with high conductivity paste within the well.

.6 Strap on style devices will not be acceptable.

.7 Acceptable Products: Marsh, Trerice, Weiss, Weksler, or equivalent.

2.9 Temperature and Pressure Relief Valves

.1 Design: A.S.M.E. rated to the input capacity of the connected system energy generating components.

.2 Acceptable Products: Watts, Cash Acme, or equivalent.

2.10 Pipe Joints

.1 Solders and fluxes shall have no lead content and self-cleaning acid type fluxes shall not be used.

.2 All copper to iron and flanged adaptors shall be brass, not copper.

.3 All unions or similar interconnections between dissimilar metals shall be dielectric couplings.

.4 Acceptable Products: Epco Dielectric Pipe Fittings, or equivalent.

.5 Where connections are made between grooved end ductile iron pipe and grooved end copper pipe, provide a Victaulic #47GG dielectric water way.

.6 Ensure all grooves for copper pipe are made with rolls and tools for copper pipe.

.7 All grooves in ductile iron pipe are to be radius cut grooves on minimum Class 53 pipe.

.8 Contractor to assure that all grooves on piping meet the coupling manufacturer's most current specifications, for the coupling that is used on that pipe connection.

2.11 Wall Penetration Seals

.1 Mechanical pipe wall penetration seals suitable for direct burial application complete with EPDM seal material, glass reinforced plastic pressure plates, stainless steel bolts and nuts, suitable for temperatures from –40C to 110C.

.2 Select sizes per manufacturer's recommendations based on inside diameter of the cored wall opening or wall sleeve, and the outside diameter of the service pipe.

.3 Standards of Acceptance: Metraflex MetraSeal model MS; Link Seal.

2.12 Air Vents

.1 Design: Automatic float type, 1035 kPa max. operating pressure.

.2 Acceptable Products: Armstrong 11-AV, Maid-o-Mist 71, Taco 426, Amtrol, or equivalent.

2.13 Hydrants and/or Hose Bibbs

.1 Hose Bibb Type 'A': (exposed non-freeze type):

.1 Exposed non-freeze self draining wall hydrant with integral backflow breaker.

.2 Loose key handle operation.

.3 Bronze casting and bronze interior parts.

.4 Stainless steel face plate.

.5 Acceptable Products: Zurn ZN-1310, Watts, Jay R. Smith, Mifab, or equivalent.

.2 Hose Bibb Type 'B': (encased non-freeze ground type):

.1 Encased non-freeze ground hydrant with hose storage for a depth of bury of 900 mm [3'] with detachable operating key, brass casing and self draining feature upon hose bibb deactivation.

.2 Acceptable Products: Zurn ZN-1370, Watts, Jay R. Smith, Mifab, or equivalent.

2.14 Trap Seal Primers

.1 Provide flow actuated type priming device piped to nearest fixture so that device will introduce regulated amount of water into trap whenever fixture is used. Do not install in branch lines to low flow faucets where the faucet flow rate is less than the flow required to activate the trap primer.

.1 Acceptable Products: Zurn Z-1022, Watts, Jay R. Smith, or equivalent.

.2 Provide pressure actuated type priming device piped where the nearest fixture is remote to the floor drain requiring trap priming.

.1 Acceptable Products: Precision Plumbing Products Model P-1, or equivalent.

2.15 Domestic Hot Water Storage Tanks & Heat Exchangers

.1 ASME code constructed vertical storage tanks with manhole openings and threaded pipe connections.

.2 Factory assembled and packaged on steel ring bases.

.3 Storage capacity 1890 litres [500 U.S. gallons] each with 1220 mm [48 inch] diameter

.4 Shell construction carbon steel rated 1030 kPa [150 psi] with epoxy lining to NSF-61 and magnesium anode rods to protect the tank lining.

.5 Immersion heat exchangers constructed of 19 mm [3/4"] 20 gauge copper tube, double wall construction, rated 1030 kPa [150 psi]. Capacity of 60 kW/h [200MBH] output with 75 litre per minute[20 usgpm] primary hydronic flow.

.6 ASME pressure and temperature relief valve, stem thermometer, water pressure gauge, and well for a BMS temperature sensor.

.7 Two tanks and heat exchangers required.

.8 Acceptable Products: A.O. Smith model HD48-500-ED, or equivalent.

2.16 Expansion Tank for Hot Water System

.1 Carbon steel expansion tank of welded construction, ASME model, stainless steel pipe connections, heavy duty butyl diaphragm, rigid polypropylene liner and integral floor stand.

.2 Acceptable Products: Amtrol model ST-120V-C, Expanflex, Therm-x-trol, Hamlet & Garneau, or equivalent.

2.17 Recirculation Pumps

.1 Hot water and tempered water recirculation pumps.

.1 Bronze body, bronze impeller for domestic hot water systems.

.2 Spring loaded coupler between motor and pump shaft, drip proof.

.3 Bronze sleeve type bearing, resilient-mount.

.4 Acceptable Products: Bell & Gosset, Armstrong, Taco, Grundfos, or equivalent.

2.18 Water Meter

.1 Two hermetically sealed direct reading centre sweep registers with remote reader, one piece cast bronze main case, low flow disc measurement and high flow turbine measurement with a hydraulic transfer valve, magnetically driven, rated for 1035 kPa service, reading in cubic metres per hour and flanged ends conforming to AWWA C700 with wall or floor mounted pads.

.2 Meters shall be equipped with a 4-20 mA output to BMS and a remote reading transmitter accessible from outside of building.

.3 Acceptable Products:

.1 Up to 50 mm: Schlumber Neptune T-10 Meter with ProRead ARB, or equivalent.

.2 Greater than 50 mm: Neptune Tru/Flo Compound Meter with ProRead ARB, Neptune High Performance Turbine Meter, or equivalent.

Part 3 Execution

3.1 Concealed Supply Piping

.1 Concealed water supply piping to plumbing fixtures, trim items, equipment, hose bibbs, etc. shall be installed using cast brass 90 degree drop ear elbow or drop ear tees as the piping design dictates.

.2 Blocking shall be provided within the concealed space and the elbows and tees shall be secured to the blocking using brass screws to provide a rigid installation.

3.2 Valve Installation

.1 General:

.2 Where possible, disassemble solder end joint valves before soldering.

.3 Where disassembly and the subsequent reassembly is impossible, the contractor shall give special regard to solder jointing in order not to damage, melt or deform and valve parts.

.4 Where grooved end pipe is used, the contractor shall incorporate grooved end valves.

.5 Valves of a common type shall be of one manufacturer.

.6 Shut Off Valves:

.1 Install shut-off or isolation valves whether shown on the drawings or not at the following locations:

.1 At the base of each building riser.

.2 At each main branch supply provide a valve on the outlet leg from the tee.

.3 At each single plumbing fixture generally in concealed spaces for all inmate accessible fixtures.

.4 At each single piece of equipment.

.5 At all points as indicated on the drawings.

.6 At all points required by the plumbing code.

.7 Balancing Valves:

.1 Install balancing valves in hot water and tempered water recirculating branch mains and branch connections to return mains whether indicated on drawings or not.

.8 Pressure Reducing Valves:

.1 Pressure reducing valve stations, as a minimum shall consist of the following:

.1 A high flow or main pressure reducing valve; which shall be one pipe size smaller than the incoming building service, and shall be provided with a strainer, a reducer and a shut off valve on the inlet side and a reducer and a shut off valve on the outlet side.

.2 A low flow pressure reducing valve shall be provided with a strainer and a shut off valve on the inlet side and a shut off valve on the outlet side.

.3 A bypass around both pressure reducing valves with a normally closed globe valve and a pressure gauge on each side of the globe valve.

.4 Set main pressure reducing valve at 415 kPa outlet pressure.

.5 Set small flow pressure reducing valve at 35 kPa higher outlet pressure than main pressure reducing valve.

.9 Drain Valves:

.1 Install drain valves 19 mm minimum, or line size where the piping is smaller than 19 mm.

.2 Install a hose-end adaptor, cap and chain on the discharge side of each drain valve or pipe to drain where indicated.

.10 Solenoid Valves:

.1 Provide in accessible locations.

.2 Provide an isolating ball valve, union and water hammer arrestor, upstream of the solenoid valve.

.3 Coordinate with the controls contractor for operation of the valves via the Building Management System (BMS).

3.3 Vacuum Breaker Installation

.1 Install at each fixture or item of equipment where contamination of the domestic water system can occur.

.2 Vacuum breaker installation shall be in complete accordance with the "Cross Connection Control Manual" published by the Pacific Northwest Section of the American Water Works Association.

.3 All atmospheric type vacuum breakers shall be installed at least 300mm above flood level rim of fixture.

.4 Provide drain pan with water deflecting enclosure on concealed pressure type vacuum breakers with drain line to appropriate drain.

.5 Complete testing of all vacuum breakers shall be carried out under this section of the work prior to final acceptance of plumbing systems. A certificate shall be submitted duly signed and witnessed that testing was satisfactory. Provide a copy in the Maintenance Manuals.

3.4 Backflow Prevention Station Installation

.1 Install at each fixture or item of equipment where contamination of the water system can occur.

.2 Pipe differential relief outlet to drain.

.3 Backflow prevention station shall be in complete accordance with the "Cross Connection Control Manual" published by the B.C. Section of the American Water Works Association.

.4 Complete testing of all reduced pressure principle backflow prevention devices shall be carried out under this section of the work prior to final acceptance of plumbing systems.

.5 A certificate shall be submitted duly signed and witnessed that testing was satisfactory. Provide a copy in the Maintenance Manuals.

3.5 Strainer Installation

.1 Install strainer blow-off connections.

.2 Blow-off connections shall be full drain connection size and shall include:

.1 Up to 50 mm - nipple and cap.

.2 65 mm and larger - nipple, globe valve and nipple.

3.6 Flanges and Unions

.1 Provide on all connections to pumps, reducing valves, control valves, fixtures, and equipment.

.2 Connections up to and including 50 mm size shall be all bronze union, 1,035 kPa rating with ground seat; larger connections shall be grooved end or flanged.

3.7 Pressure Gauges

.1 Install pressure gauge at all pump suction and discharge points and at each pressure reducing station inlet and outlet complete with snubbers and ball valves.

3.8 Water Hammer Arrestors

.1 Size in accordance with the Plumbing and Drainage Institute PD1-WH-201 sizing procedures.

.2 Install on branch lines to flush valves, solenoid valves, self-closing faucets, quick closing valves and on refrigeration, kitchen and laundry equipment incorporating solenoid valves.

3.9 Thermometers

.1 Install at domestic hot water generator outlet.

.2 Locate for ease of readability and such that their sensing elements are directly in the flowing medium and immediately adjacent to the sensing elements.

.3 When installed to sense the water temperature in a pipe, install its sensing element in a non-ferrous, separable well filled with a heat conducting paste. Install the separable well in a form which minimizes the restriction to water flow; if necessary, in a section of oversized pipe.

3.10 Pipe Joints

.1 Install dielectric type couplings or fittings where copper piping and accessories connect to plumbing equipment such as steel storage tanks or pressure reducing stations.

.2 Where the water service enters the building terminate at the edge of the building and excavation with a Smith Blair standard sleeve coupling having stainless steel nuts and bolts. Bridge the excavation with ductile iron pipe.

.3 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.

.4 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.

3.11 Exterior Wall Penetrations

.1 Provide a heavy bead of waterproof caulking on the exterior side of the penetration, wherever water piping penetrates the exterior wall of the building above grade. Smooth the surface of the caulking for a neat finished appearance sloped to shed water from ponding.

.2 Provide mechanical water stop seals wherever water piping penetrates the exterior wall of the building below grade, including the main building water entry service pipes.

3.12 Air Vents

.1 Install at all high points in domestic hot water recirculation systems.

.2 Install on tees and not on horizontal piping or radiused elbows.

.3 Install 12 mm minimum isolating ball valve ahead of each air vent.

.4 Pipe all air vent discharge connections separately to nearest building drain using 6 mm hard drawn copper.

3.13 Hydrants and/or Hose Bibbs

.1 Provide operating keys to the Departmental for all hose bibbs that do not possess an attached handle.

.2 Provide an isolating shut-off valve upstream of all hose bibbs.

.3 Mount hose bibs at nominally 450 mm above grade, set plumb and square.

.4 Provide a neat bead of caulking around the perimeter of the hose bibb of a color to match the adjacent finished wall surface. High quality workmanship is required.

.5 Exterior ground type hose bibb boxes shall be set flush and anchored in a 460 mm square x 200 mm thick concrete collar all set at 25 mm above surrounding grade.

3.14 Trap Seal Primers Valves

.1 Provide floor drain trap primers in water closet rooms and other areas in accordance with the plumbing code and as designated on the drawings.

.2 Install at locations that are readily accessible by the building maintenance staff.

3.15 Domestic Hot Water Storage Tanks & Heat Exchangers

.1 Mount units complete with seismic restraints.

.2 Pipe relief port full outlet size to drain. Position discharge at drain to prevent splash-over.

.3 Provide isolating valves and unions at all water heater pipe connections such that either unit can be independently isolated.

.4 Locate isolating valves and unions such that any individual tank or heater may be removed from service without disruption to any other piece of equipment.

.5 Provide vacuum relief valves on the cold water inlet pipe above each tank.

.6 Field insulate the tanks minimum 50mm [2”] per Section 23 07 16.

.7 Provide a full commissioning and start-up report for each unit, including testing of all high limit safety devices.

3.16 Recirculation Pumps

.1 Building recirculation pumps:

.1 Coordinate with the Electrical Division for the provision of a manual disconnect switch with wiring to the pump.

.2 Provide check valve on the recirculation pump discharge.

.3 Provide isolating ball valves upstream of the pump and downstream of the check valve.

.4 Provide straight runs of piping upstream of each pump.

.5 Support the pumps at the flanges, independent of the adjacent piping.

.6 Coordinate with the controls trade for operation of the pump via a dedicated time clock function of the Building Management System (BMS).

3.17 Testing and Inspection

.1 Testing shall consist of hydraulic pressure testing at 1,400 kPa for 8 hours.

3.18 Chlorination

.1 Chlorinate the entire potable water systems in accordance with AWWA Standards, including flushing.

.2 Provide a 'Chlorination Certificate' at substantial completion and provide a copy in the Maintenance Manuals.

.3 This work shall be done by a qualified certified water treatment company. Provide proof of certification.

3.19 Sensors and Flow Switches

.1 Provide line size x line size x 19 mm branch tees complete with brass or copper sweat x

.2 F.I.P. adapters to accept water temperature sensors and flow switches on the domestic hot water systems.

.3 Provide one tee on the downstream side of the domestic water heaters. The controls contractor will provide and install water temperature sensors and connect to the Building Management System (BMS) to monitor temperature and indicate a high temperature alarm.

.4 Provide one tee on the downstream side of each domestic hot water recirculation pump. The controls contractor will provide and install flow switches and connect to the BMS to monitor and provide system flow indication.

END OF SECTION

Part 1 General

1.1 Work Included

.1 The General Conditions, Supplements and Amendments shall govern this Division (read in conjunction with Instructions to Tenderers / Bidders). This section covers items common to all sections of Division 22 and 23 and is intended only to supplement the requirements of Division 1.

.2 Coordinate with Division 7 for requirements/scope definition on security fasteners and caulking.

.3 Coordinate with Division 9 for requirements/ scope definition on painting.

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

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

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

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

.8 Provide record as-built drawings.

.9 Provide maintenance program.

1.2 Standard of Acceptance / Acceptable Materials

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

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

.3 Where other than the underlined manufacturer or scheduled/specified manufacturer is selected or approved, include for the cost of any

resulting work (both under this Division and other Divisions) and any necessary redesign of installation or structure. Submit redesign drawings for review with Shop Drawings. Maintain installation, access and servicing clearances. Redesign drawings shall be to scale and of a standard equal to the Project Drawings.

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

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

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

1.3 Tender Inquiries

.1 All contractor queries during the tender period shall be made in writing to the Departmental Representative. Contractor queries will be collected and suitable addenda will be issued for clarification. No verbal information will be issued by the Departmental Representative's office during tender. All tender queries may be faxed, mailed or couriered to the Departmental Representative's office. No telephone questions will be answered.

1.4 Detailed Price Breakdowns

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

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

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

1.5 Progress Claims

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

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

.3 Progress claims will not be certified nor payment made beyond 90% on the overall Mechanical contract and beyond 70% on the Control

systems contract, until commissioning and verification of the systems are complete. (The 70% limit on Controls is included in the overall fig.). This procedure is to allow for any necessary deficiency holdbacks on items which do not become apparent until the systems are commissioned.

1.6 Scheduling

.1 Coordinate with Section 01 01 50 – General Instructions (CSC).

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

.1 Installation and testing of piping systems and equipment.

.2 Installation and cleaning of duct systems and equipment.

.3 Chemical cleaning and treatment of piping.

.4 Control system installation.

.5 Air/Water balancing

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

.7 Start-up of mechanical equipment and systems.

.8 Check-out of control systems.

.9 Commissioning of mechanical systems.

.10 Demonstration of systems and equipment to Departmental Representative.

.11 Demonstration of systems and equipment to departmental representative.

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

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

1.7 Responsibilities

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

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

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

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

1.8 Coordination

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

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

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

1.9 Provision for Future Equipment and Construction

.1 Leave clear spaces designated for future equipment or building expansion. Where dotted lines indicate future installation of ducting, equipment etc. Plan for the installation under this contract and ensure clear accessible, unhindered access to the space is allowed for.

.2 Were contract documents don't clearly indicate the future expansion requirements, but known services are required, provide written "request for information" to the Departmental Representative before making assumptions as to intent.

1.10 Phased Construction

.1 Refer to specifications and drawings for construction phasing. Make all allowances to phase the work in accordance with the project phasing.

.2 All existing services and the existing building(s) must be maintained in operation. Provide and install temporary services as required.

.3 All trades in this Division shall make allowance for the implications of having to totally complete all work of one stage before proceeding with work on the next stage.

.4 The building shall be maintained operational throughout the duration of the work. Maintain all services, and minimize disruption to normal operation of the facility. Coordinate with Departmental Representative.

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

1.11 Permits

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

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

1.12 Codes, Regulations and Standards

.1 Division 22 and 23 work shall conform to the following codes, regulations and standards, and all other codes in effect at the time of award of Contract, and any others having jurisdiction. The latest revision of each code and standard shall apply unless otherwise specified in the contract documents:

.1 Bylaws

.1 Local Building Bylaws.

.2 Canadian Gas Association

.1 National Standard of Canada CAN/CGA-B149.1-00. Natural Gas Installation Code.

.3 Canadian Standards Association

.1 CSA Standard B139-04 R 2014, Installation Code for Oil Burning Equipment.

.2 CAN/CSA-C22.1-09: Canadian electrical code, part I, safety standard for electrical installations.

.3 CAN/CSA-C22.2 No.0.3-09: Test methods for electrical wires and cables.

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

.5 CSA Standard B52-13 Mechanical Refrigeration Code.

.4 National Research Council of Canada

.1 NRCC - National Building Code of Canada 2010.

.2 NRCC - National Building Code of Canada, Revisions and Errata - 2012.

.3 NRCC 54435 National Energy Code of Canada for Buildings (NECB) – 2011

.4 NRCC 53302 National Plumbing Code of Canada – 2010

.5 NRCC 53303 National Fire Code of Canada – 2010.

.5 Province of British Columbia

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

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

.3 B.C. Electrical Safety Branch Bulletins.

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

.5 Electrical Safety Regulation (B.C. Reg. 100/2004)

.6 B.C. Safety Authority Safety Standards Act

.7 B.C. Safety Authority Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation (B.C. Reg. 104/2004)

.8 B.C. Safety Authority Gas Safety Regulation (B.C. Reg. 103/2004).

.9 B.C. Occupational Health & Safety (OHS) Regulations, WorkSafeBC

.10 B.C. Fire Code 1998.

.6 SMACNA Publications

.1 ANSI/SMACNA 006: H.V.A.C. Duct Construction Standards, Metal and Flexible (2005, 3rd Edition)

.2 Guidelines for seismic restraints of mechanical systems

.3 SMACNA 008-2008 (2007) – IAQ Guidelines for

Occupied Buildings Under Construction, 2nd Edition

.4 SMACNA 016-2012 – HVAC Air Duct Leakage Test Manual, 2nd Edition

.5 SMACNA 1108 (2008) – Accepted Industry Practice for Industrial Duct Construction, 2nd Edition

.6 SMACNA 1819 (2002) – Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems, 5th Edition.

.7 Miscellaneous Standards

.1 ANSI/ASHRAE Standard 62 – 2001 Ventilation for Acceptable Indoor Air Quality (except Addendum n)

.2 ANSI/ASHRAE/IES Standard 90.1 – 2010 – Energy Standard for Buildings Except Low-Rise Residential Buildings

.3 Thermal Insulation Association of Canada – TIAC Best Practices Guide

.4 British Columbia Insulation Contractors Association – BC Insulation Contractors Association (BCICA) Standards Manual

.5 Environment Canada CEPA 1988 Canadian Environment Protection Act, Section 8, Part 1

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

1.13 Warranty

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

.2 Take note of any extended warranties specified.

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

1.14 Energy Consumption

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

1.15 Asbestos

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

1.16 Workmanship

.1 Workmanship shall be in accordance with well established practice and

standards accepted and recognized by the Departmental Representative and the Trade.

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

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

1.17 Drawings and Measurements

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

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

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

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

1.18 Concealment

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

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

1.19 Accessibility

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

1.20 Piping Expansion

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

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

.3 Anchors shall be fabricated from mild steel plate and structural steel

angle and channel sections, in accordance with ANSI B.31.

1.21 Protection of Work

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

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

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

.4 Refinish damaged or marred factory finish.

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

1.22 Sequence of Work

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

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

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

1.23 Building Operation During Construction

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

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

.3 Follow security and safety procedures on-site.

1.24 Existing Services

.1 Protect all existing services encountered. Every effort has been made to show the known existing services. However, the removal of concealing surfaces may reveal other existing services. Work with the building staff to

trace the originating source and points served. Obtain instructions from the Departmental Representative when existing services require relocation or modifications, other than those already indicated in the Contract Documents.

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

.3 Shutdowns, to permit connections, will be carried out in cooperation with maintenance staff.

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

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

.6 The interruption of utility services to permit tie-ins shall be arranged through the Departmental Representative. Application must be received in writing at least seven (7) calendar days prior to the date required for the shutdown. The departmental representative reserves the right to withhold permission for a reasonable period with respect to any shutdown, if the shutting-off of a service will interfere with important operations of the facility.

1.25 Shop Drawings/Product Data

.1 Process

.1 Shop drawings/product data shall be submitted as listed in Sections 01 33 00, 22 05 00, and as described in the respective equipment specification section.

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

.2 Content

.1 Shop drawings submitted title sheet.

.2 Data shall be specific and technical.

.1 Identify each piece of equipment.

.2 Information shall include all scheduled data.

.3 Advertising literature will be rejected.

.4 The project shall be identified on each document.

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

.6 The shop drawings/product data shall include:

.1 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary

clearances, with all equipment weight's and mounting point loads.

.2 Mounting arrangements.

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

.4 Sound Power Data, where requested.

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

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

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

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

.9 Electrical control system drawings.

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

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

.12 Refer to additional requirements in Section 15900.

.3 Format

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

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

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

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

.4 Coordination

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

.2 Submit shop drawings and product data.

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

1.26 Equipment Inventory Sheets

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

1.27 Equipment Restraint

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

1.28 Equipment Installation

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

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

.3 Pipe equipment drains to floor drains.

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

1.29 Anchor Bolts and Templates

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

1.30 Access Doors (applies only for not secured areas)

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

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

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

.1 Access doors in fire separations of 3/4 hour rating, and higher, and

firewalls shall have a compatible fire rating and a ULC label with tamper-proof latch, self closing.

.4 Minimum Requirements:

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

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

.1 Acceptable Product: Acudor PS-5030, or equivalent.

.3 Masonry or drywall construction: 16 gauge for 400 mm [16"] x 400 mm [16"]

.4 and smaller, 14 gauge for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange.

.1 Acceptable Product: Acudor UF-5000, or equivalent.

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

.1 Acceptable Product: Acudor PS-5030 stainless, or equivalent.

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

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

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

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

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

1.31 Cutting, Patching, Digging, Canning and Coring

.1 Lay out all cutting, patching, digging, canning and coring required to accommodate the mechanical services. Coordinate with other Divisions. The performance of actual cutting, patching, digging, canning and coring is specified under other Divisions. Be responsible for correct location and sizing of all openings required under Division 22 and 23 including pipe sleeves and duct openings. Allow oversized openings for fire dampers and pipe penetrations where insulation is specified.

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

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

1.32 Fastening to Building Structure

.1 General:

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

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

.2 Types:

.1 Cast-in-place type:

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

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

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

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

.2 Drilled, mechanical expansion type:

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

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

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

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

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

.3 Drilled, adhesive type:

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

.2 Hilti HY150, or equivalent, consisting of anchor rod with a 2-

part adhesive system.

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

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

.3 Note:

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

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

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

1.33 Miscellaneous Metal

.1 Be responsible for all miscellaneous steel work relative to Division 22 and 23 of the Specifications, including but not limited to:

.1 Support of equipment - including cooling tower.

.2 Hanging, support, anchoring, guiding and relative work as it applies to piping, ductwork, heat exchangers, hot water storage tanks, expansion tanks, fans and mechanical equipment.

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

.4 Access platforms, ladders and catwalks.

.5 Pipe anchor and/or support posts.

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

1.34 Service Penetrations in Rated Fire Separations

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

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

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

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

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

.1 Between fire damper sleeve angles and the sleeves and

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

1.35 Service Penetrations in Non-Rated Separations

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

1.36 Pipe Sleeves

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

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

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

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

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

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

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

.8 Pipe sleeves shall extend 25 mm [1"] on each side of walls in unfinished

areas and 6 mm [1/4"] in finished areas.

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

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

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

.12 Packing of Sleeves:

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

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

1.37 Escutcheons and Plates

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

.2 Plates shall be stamped steel, split type, chrome plated, or stainless steel, concealed hinge, complete with springs, suitable for external dimensions of piping/insulation. Secure to pipe or finished surface. For all pipes passing through suspended ceilings and uninsulated piping passing through walls. Outside diameter shall cover opening or sleeve.

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

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

1.38 Duct and Pipe Mounted Control Equipment

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

.1 Automatic control valves.

.2 Temperature control wells.

.3 Pressure tappings.

.4 Flow switches.

.5 Automatic control dampers.

.6 Static pressure sensors.

.7 Flow stations (air/liquid).

.8 Pressure switches.

.9 Level indicators.

.10 Pressure differentials.

1.39 Electric Motors

.1 Provide motors for mechanical equipment as specified.

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

.3 Motors shall be UL listed and CSA certified.

.4 Full Voltage Start Applications:

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

.5 Variable Frequency Drive and soft start applications:

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

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

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

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

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

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

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

HP	Minimum Efficiency (%)		
	3600 RPM 2 Pole	1800 RPM 4 Pole	1200 RPM 6 Pole
1	75.5	82.5	80.0
1.5	82.5	84.0	85.5

2	84.0	84.0	86.5
3	85.5	87.5	87.5
5	87.5	87.5	87.5
7.5	88.5	89.5	89.5
10	89.5	89.5	89.5
15	90.2	91.0	90.2
20	90.2	91.0	90.2
25	91.0	92.4	91.7
30	91.0	92.4	91.7
40	91.7	93.0	93.0
50	92.4	93.0	93.0

1.40 Miscellaneous Motor Requirements

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

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

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

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

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

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

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

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

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

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

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

1.41 Belt Drives

.1 Provide belt drives to the following requirements:

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

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

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

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

.2 Match drive and driven sheaves.

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

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

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

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

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

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

1.42 Shaft Couplings

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

1.43 Setting and Alignment

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

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

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

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

system balance adjustment.

1.44 Guards

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

.2 Guards for drives shall have:

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

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

.3 Removable side[s] for servicing.

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

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

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

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

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

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

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

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

1.45 Equipment Supports

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

.2 Lay out concrete bases and curbs required under Division 21, 22 and 23. Coordinate with respective division. For all concrete work.

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

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

In-Pakt, or equivalent.

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

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

.7 Lay out laminated wood bases required under Division 21, 22 and 23, coordinate with respective division in rooms with wood structure floors. Bases shall be a nominal 100 mm [4"] thick unless otherwise directed. Wood members shall be securely spiked together and all corners shall be chamfered at 45 degrees.

1.46 Dielectric Couplings

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

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

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

.4 Acceptable Materials: Capital, Walter Vallet, EPCO, or equivalent.

1.47 Lubrication of Equipment

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

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

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

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

1.48 Painting

.1 Clean exposed bare metal surfaces supplied under Division 21, 22 and 23, removing all dirt, dust, grease and millscale. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.

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

.3 Repaint all marred factory finished equipment supplied under Division 21, 22 and 23, to match the original factory finish.

.4 Coordinate with respective division for painting.

.5 Painting of all equipment and materials, supplied under Division 21, 22 and 23, installed in mechanical equipment areas and inside finished areas of the building or exposed outside the building, is included under respective painting division of the Specification.

.6 Match existing standard and colour scheme.

.7 Painting by respective Division shall be in accordance with the following Colour Schedule for Mechanical Equipment Areas (in the absence of the existing colour scheme reference):

Item	**Colour Finish**
Boiler Shells and Boiler Control Panels	Blue
Boiler Supports	White
Breeching (uninsulated)	Aluminum (high temp.)
Catwalks and Ladders	Grey
Condensers (uninsulated)	Blue
Ductwork, Plenums and Miscellaneous Steel	
not galvanized	Grey
galvanized	White
plenum access doors and 200 mm around	Grey
Fan Casings and Bases	Grey
Guards – Belt and Coupling	To match associated
Handrails	Aluminum
Heat Exchanger Heads and Shells	Aluminum (high temp.)
Insulation Covering (on piping, tanks, heat exchangers,	White
Motors (electric)	To match associated
Piping (uninsulated)	
Fire lines (standpipes, sprinklers)	Red
Gas (natural)	Yellow
Services other than above	White
Pot Feeders (Chemical)	Aluminum
Pump Bodies (uninsulated) and bases	Blue
Tanks and Supports	White
Valve Bodies (uninsulated)	
Hot water heating, antifreeze heating	Aluminum (high temp.)
Services other than above	To match associated piping

1.49 Clean-up for Painting

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

.2 All miscellaneous metal work furnished under this Division shall be supplied with one shop coat of primer for finished enamel painting. After erection or installation, whichever is appropriate, apply one coat

of undercoat in readiness for finish painting. Preparatory work on all surfaces, prior to painting, shall be in accordance with the recommendations of the paint manufacturer.

1.50 Start-Up

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

.1 All safety controls installed and fully operational.

.2 Qualified personnel available to operate the plant.

.3 Permanent electrical connections made to all equipment.

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

.5 All air filters installed.

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

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

1.51 Spare Parts

.1 Provide spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One head gasket for each heat exchanger.

.4 One glass for each gauge glass installed.

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

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

1.52 Cleaning and Final Adjustment

.1 Clean mechanical systems daily.

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

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

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

1.53 Record Drawings

.1 Refer to Division 1 (Section 01 78 00, clause 1.7 “As Constructed drawings and samples”) for additional requirements to those listed below. Maintain one set of contract drawing white prints, including all supplementary and

revision drawings on site, solely for the purpose of recording, in red, any change and/or deviation from the Contract Drawings as it occurs. Include elevations and detailed locations of buried services.

.2 The set of white prints will be provided to the contractor by the Departmental Representative at the contractors cost.

.3 The marked-up set of prints shall be reviewed on site monthly by the Departmental Representative during the construction process. This review will form a requirement for approval of the monthly progress claim.

.4 Back filling shall not occur until underground services dimensions are marked on the prints,

.5 The Record Drawings shall include, but not limited to, the following changes and shall be recorded daily:

.1 Size, location, arrangement, routing and extent of ductwork, piping, terminal units, equipment, fixtures, clean-outs, valves, rough-in, etc. above and below grade inside the building and including dimensioned locations of buried piping from building walls

.2 Location of fire dampers.

.3 Location of all heat traced piping and associated controllers.

.4 Location of back flow preventers.

.5 Location of water hammer arrestors.

.6 Water lines: Invert elevations to be recorded at each junction, changes of direction and every 30 m [100 ft] run.

.7 Sanitary Sewers: Invert elevations and locations to be recorded at each clean- out.

.8 Storm Drains & Sewers: Invert elevations to be recorded at each manhole, clean-out, changes of direction and every 30 m [100 ft] run.

.9 Gas Lines: Invert elevations to be recorded at each junction, at building entry point and at changes of direction.

.10 All services located below ground level and in or below a building slab.

.11 All valve stations, trap stations, coils dampers and ductwork not easily accessible.

.12 Location, tagging and numbering of all valves as specified in Section 23 05 53.

.6 CAD Drafting:

.1 Obtain a set of CAD files from the Departmental Representative. Obtain the services of a qualified CAD draftsperson to transfer all

as-built changes to amend the CAD files.

.2 Include all details from revision drawings, addenda, and change orders. Label each drawing in the lower right corner in letters of at least 12mm [1/2"] high as follows:

.1 "AS BUILT DRAWINGS", Contractors name and date.

.3 Provide one set of check prints for review by Departmental Representative.

.4 Upon acceptance by the Departmental Representative, provide computer CAD files and one set of plots [0.03 mm mylar sepias plots].

1.54 MAINTENANCE PROGRAM

.1 Employ the agency, which is preparing the operating and maintenance manuals, to prepare maintenance schedules suitable for inputting into the existing computerized maintenance program. Obtain from the Departmental Representative the format in which the schedules should be prepared.

.2 Maintenance Schedules:

.1 The maintenance schedules shall detail preventative maintenance procedures and their required frequency (daily, weekly, monthly, quarterly, half yearly, yearly and seasonally) for each system.

.2 Major items of equipment, such as boilers, heat pumps and dry fluid coolers, AHU's, etc. shall be listed on individual schedules.

.3 Equipment Maintenance Record Cards

.1 A record card shall be prepared for each piece of equipment (including major plumbing equipment) stating its identifying name, unit number, manufacturer, model number, local supplier, serial number and all data relative to its operation and maintenance.

.4 After substantial performance has been declared, the agency shall visit the facility to explain and instruct the Departmental Representative on the use of the maintenance program.

END OF SECTION

Part 1 General

1.1 Related Work

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

Part 2 Products

2.1 General

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

2.2 Thermometers - Piping

.1 Acceptable Manufacturers:

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

.2 Minimum Requirements:

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

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

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

.3 Case:

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

.4 Scale:

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

.2 White background with temperature range in black.

.3 Dual Celsius and Fahrenheit scale.

2.3 Pressure Gauges - Piping

.1 Acceptable Manufacturers:

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

.2 Minimum Requirements:

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

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

.3 White background with pressure range in black.

.4 Dual kilopascal and psig scale.

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

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

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

.8 ULC listed for use on fire protection systems.

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

.3 Accessories:

.1 Install a needle valve ahead of each gauge.

2.4 Test Thermometer

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

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

2.5 Thermometer Wells

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

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

Part 3 Execution

3.1 General

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

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

3.2 Thermometers

.1 Install in wells on all piping.

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

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

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

.1 Heat exchangers.

.2 Water heating coils.

.3 Water boilers.

.4 DHW tanks.

.5 Fluid cooler.

.6 Heat pumps.

.7 As shown on schematic drawing.

.5 Use extensions where thermometers are installed through insulation.

3.3 Pressure Gauges

.1 Install in following locations:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 Inlet and outlet of waterside of coils (excluding terminal unit coils) and heat exchangers.

.4 In other locations as indicated.

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

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

END OF SECTION

Part 1 General

1.1 Related Work

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

1.2 General

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

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

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

.4 Do not suspend from metal deck.

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

Part 2 Products

2.1 Upper Attachments

.1 Concrete:

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

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

.2 Steel Beam (bottom flange):

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

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

.3 Steel Beam (top):

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

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

.4 Steel Joist:

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

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

.5 Steel Channel or Angle (bottom):

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

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

.6 Steel Channel or Angle (top):

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

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

2.2 Middle Attachments (rod)

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

2.3 Pipe Attachments

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

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

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

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

.5 Spring hangers; where required to offset expansion on horizontal runs

which follow long vertical risers - Grinnell/Anvil fig. 171 single pipe roll hanger with Grinnell/Anvil fig. 178, or equivalent.

2.4 Riser Clamps

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

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

2.5 Saddles and Shields

.1 Cold piping NPS 2 and under: protection shield with pipe insulation under shield with uninterrupted vapour barrier – Kingspan "K Block" – high density insulation, or equivalent.

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

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

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

2.6 Wall Supports

.1 Horizontal pipe adjacent to wall:

.1 Angle iron wall brackets with specified hangers.

.2 Vertical pipe adjacent to wall.

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

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

2.7 Floor Supports

.1 Horizontal pipe.

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

.2 Vertical pipe.

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

Part 3 Execution

3.1 Hanger Spacing

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

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

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

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

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

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

.2 Maximum hanger spacing table.

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

3.2 Hanger Installation

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

.2 Adjust hangers to equalize load.

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

END OF SECTION

Part 1 General

1.1 Related Work

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

1.2 Regulatory Requirements

.1 Supply isolators and seismic restraints meeting the structural requirements of the National Building Code of Canada 2005, Division B, including Section 4.1.8.17. with respect to seismic snubbers, or provide equivalent requirements where integral seismic restraint is provided in isolators / bolting.

.2 Include National Building Code of Canada 2005 , Division B, Section 6.2.1.8.(2) Vibration isolator housings are considered a safety guard with respect to isolated equipment and any contained compressed springs. Include "Fail Safe" seismic restraint in all vibration isolation designed to hold mechanical equipment and springs in place.

1.3 Shop Drawings, Qualifications and Submittals

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

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

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

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

1.4 General

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

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

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

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

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

.6 Coordinate with Division 3 for the provision of housekeeping pads at least 100 mm [4"] high under all isolated equipment, or greater thickness where specified. Provide at least

.7 300 mm [12"] clearance between drilled inserts and edge of housekeeping pads. Housekeeping pads to be tied to structure with reinforcement to meet Code seismic requirements.

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

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

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

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

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

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

Part 2 Products

2.1 Isolators - General

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

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

.3 Design springs in accordance with the Society of Automotive Engineers' Handbook Supplement 9 entitled "Manual on Design and Application of Helical and Spiral Springs - SAE - 1975". Provide neoprene isolators and components using maximum 60 duro "Bridge bearing quality neoprene", as defined by CSA Standard CAN3-S6-M78 Section

.4 11.10. Ensure design of isolation and restraint elements allows adequate clearance to avoid binding.

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

.6 0.6 of solid deflection.

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

2.2 Isolators - Type 1, Pads

.1 Neoprene or neoprene / steel / neoprene pad isolators. Select Type 1 pads for a minimum

.2 2.5 mm [0.1"] static deflection or greater. Use hold down bolts selected for seismic loads.

.3 Isolate bolts from base of unit using neoprene hemi-grommets. Avoid over-compressing grommets (e.g. use Hilti HVA adhesive set bolts, or equivalent, with steel washers and lock nuts, adjusted finger tight to the hemi-grommets). Size bolt and hemi-grommet for minimum lateral clearance. Use grommets only on light-weight equipment.

.4 Acceptable Materials:

.1 Mason WMW, Super W pads

.2 Mason Industries Type HG Hemi-Grommets

.3 EAR Grommets

.4 Or equivalent.

2.3 Isolators - Type 2, Rubber Floor Mounts

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

.2 Acceptable Materials:

.1 Mason BR, maximum 50 durometer.

.2 Or equivalent.

2.4 Isolators - Type 3, Spring Floor Mounts

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

.2 Acceptable Materials:

.1 Mason SSLFH.

.2 Or equivalent.

2.5 Isolators - Type 4, Hanger Mounts

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

.2 Acceptable Materials:

.1 Mason HD, HS.

.2 Or equivalent.

2.6 Isolators - Type 6, Seismic Snubbers.

.1 Seismic snubbers c/w minimum 3mm [1/8"] neoprene bushing and 6mm

[1/4"] air gap. Snubber to act omni-directionally. Ensure bushing can easily be turned by hand after installation

.2 Acceptable Materials:

.1 Manson Z-1225.

.2 Or equivalent.

2.7 Closed Cell Foam Gaskets / Neoprene Grommets - Type 7

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

.2 Acceptable Materials:

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

.2 Mason Industries Type HG Hemi-Grommets,

.3 Or equivalent.

2.8 Pipe Riser Guide / Anchor - Type 8

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

.2 Acceptable Materials:

.1 Mason ADA and VSG (H), or equivalent.

.2 Generator exhausts, PRV stations, etc - CMT VA 50247/25 Cushions, CMT W302 isolators, or equivalent.

2.9 Flexible Connectors – Type 9

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

.2 Acceptable Materials:

.1 Mason MFTNC Connector, or equivalent.

.2 Mason ACC Control Cables, or equivalent.

Part 3 Execution

3.1 Installation

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

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

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

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

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

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

.7 Use Type 1 pads only where specified.

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

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

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

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

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

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

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

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

.16 Rooftop Air Handling Units:

.1 Isolate rooftop air handling units on 50 mm x 50 mm x 20 mm [2”

x 2" x ¾"] Type 1 neoprene waffle pads. Space waffel pads for nominal 276 kPa [40 psi] under weight of rooftop unit.

.2 Use hold down bolts selected for seismic loads. Isolate bolts from base of unit using neoprene hemi-grommets. Avoid over-compressing pads/gasket. Use Hilti HVA adhesive set bolts, or equal, with steel washers and lock nuts, adjusted finger tight to hemi-grommets. Size bolts and hemi-grommet for minimum lateral clearance.

.3 Where underside of AHU is a return plenum, provide 25 mm x 20 mm [1" x ¾"] thick continuous perimeter closed cell foam neoprene gasket (Type 7) between pads.

.4 Isolate all equipment within rooftop units in accordance with this section, including fans, compressors, pumps and piping. Ensure structure borne transmission of noise from rooftop unit is less than airborne transmission.

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

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

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

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

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

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

noise transmission. Provide isolation meeting all seismic requirements.

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

3.2 Inspections

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

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

END OF SECTION

Part 1 General

1.1 Related Work

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

1.2 Regulatory Requirements

.1 Restraints shall meet the requirements of the National Building Code of Canada 2005, Division B, Section 4.1.8.17., table 4.1.18.17.

1.3 Seismic Restraint Design and Inspection

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

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

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

1.4 Submittals

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

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

1.5 Application

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

1.6 Scope of Work

.1 Provide restraint on all piping, ductwork, equipment and machinery which is part of the building mechanical service systems to prevent injury or hazard to persons and equipment and to retain equipment in its normal position in the event of an earthquake. This specification covers equipment which is not specifically covered in SMACNA.

.2 Provide all seismic restraint related hardware, (including bolts and anchors) from point of attachment to equipment through to and including attachment to structure.

.3 When equipment is mounted on concrete housekeeping pads, and / or concrete curbs the anchor bolts shall extend through the pad into the structure.

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

.5 Seismic restraints may only be omitted where permitted by SMACNA.

Part 2 Products

2.1 General

.1 Mason Type SCB (Seismic Cable Brace) slack cable restraints supplied by Vibra-Sonic Control, or equivalent.

.2 Restraint systems as indicated in 1998 SMACNA "Seismic Restraint Manual Guidelines for Mechanical Systems" (second edition), Seismic Hazard Level SHL A. If lesser restraint than recommended by SMACNA SHL A is proposed to meet local Code seismic requirements, provide shop drawings of details certified by a B.C. registered structural Engineer.

Part 3 Execution

3.1 General

.1 It is the responsibility of the contractor to ascertain that an appropriate size device be selected for each individual piece of equipment.

.2 The following are guidelines for some items not covered in SMACNA but certified shop drawings should still be submitted. Note that this list is not intended to cover all equipment requiring restraints.

3.2 Air Terminals

.1 Where air terminals are installed in mechanical grid ceilings, provide at least two 12 ASWG galvanized steel wire seismic security bridles per air terminal tied either to the building structure or to ceiling hanger wires.

.2 Attach security bridles at opposite corners of each air terminal and in such a manner that the air terminal cannot fall.

.3 Provide all necessary brackets for attachment of security bridles to the air terminals.

3.3 Non-Isolated Floor Mounted Equipment

.1 Bolt all non-isolated equipment and machinery, e.g. floor mounted tanks, heat exchangers, boilers, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the centre of gravity. For

equipment which may be subject to resonances, use a nominal 2.0g seismic force.

3.4 Isolated Piping and Equipment

.1 Install cables using appropriate grommets, shackles, and other hardware to ensure alignment of the restraints and to avoid bending the cables at connecting points.

.2 Connect slack cable restraints to ceiling hung equipment in such a way that the axial projection of the wires passes through the centre of gravity of the equipment.

.3 Vary adjacent spacing of restraints on a piping run by 10% to 30% to avoid coincident resonances.

.4 Install restraints at least 50 mm [2"] clear of all other equipment and services.

.5 Adjust restraint cables such that they are not visibly slack, or such that the flexibility is approximately 40 mm [1-1/2"] under thumb pressure for a 1.5 m [5 ft] cable length (equivalent ratio for other cable lengths). Adjust the clearance at cable strap/spacer piece restraints to not exceed 6 mm [1/4"].

.6 Provide transverse and axial restraints as close as practical to a vertical bend.

.7 At steel trusses, connect to top chords and follow truss manufacturer's instructions.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 EQUIPMENT

.1 Manufacturer's Nameplates:

.1 Each piece of manufactured equipment shall have a metal nameplate, with raised or recessed letters. Mechanically fasten plate to equipment.

.2 Manufacturer's nameplates shall indicate manufacturer's name, equipment model, size, serial number and electrical characteristics and pertinent information for any other services connections.

.3 Include ULC, (Underwriters' Laboratories Canada) and CSA, (Canadian Standards Association) registration logos and those of other agencies, as required by the respective agencies.

.4 Nameplates shall be located so that they are easily read. Do not insulate or paint over nameplates.

.5 Each piece of equipment shall be identified with its equipment schedule identification, e.g. supply fan SF-1, heating coil HC-1, pump P-1.

.2 System Nameplates

.3 Identification letters shall be 50 mm [2"] high black letters on a white background, sized to suit the label or, provide laminated plastic plates with black face and white centre of minimum size 90 mm x 40 mm x 2.5 mm [3-1/2" x 1- 1/2" x 3/32"] engraved with 6 mm [1/4"] high lettering. Use 25 mm [1"] high lettering for major equipment.

.4 Apply nameplates securely in conspicuous places, on cool surfaces.

.5 Identify systems, and areas or zones of building being serviced.

1.3 PIPING

.1 Piping Identification:

.1 Each piping system shall be colour coded for identification and labelled with the system identification code letters, including temperature and pressure, if applicable, and directional flow arrows in accordance with the Pipe Identification Colour Schedule. See diagram for sizes of lettering and bands.

.2 Identify piping adjacent to valves and where valves are in series at no more than 2 m [6'-6"] intervals. Identify piping at least once in each room and at 15 m [50 ft.] maximum spacing in open areas. Exception: gas piping to be identified at 2 m [6'-6"] intervals in ceiling plenums.

.3 Identify piping both sides where piping passes through walls, partitions and floors.

.4 Identify piping at point of entry and leaving each pipe chase and/or confined space.

.5 Identify piping accessible at each access opening.

.6 Identification labels may be stencilled. Identification arrows labels and letters may be vinyl cloth (Brady B500, or equivalent) or vinyl film (Brady B946, or equivalent), with adhesive compatible with the surface temperature.

.7 Identification colour bands for primary and secondary colours to indicate the type and degree of hazard shall be applied to overlap a minimum of 150 mm [6"]. Ends to be stapled. Bands shall be Brady B550 vinyl cloth tape, or equivalent; or Brady B946 vinyl tape, or equivalent; with adhesive compatible with the surface temperature.

.2 Valve Tags

.1 Provide valve identification tags and secure them using non-ferrous chain braided band or plastic band (suitable for temperature). Tags may be of brass, aluminum, metalphoto, lamicoid or fiberglass, stamped or engraved, of 25 mm [1"] minimum diameter.

.2 Valves to be tagged include:

.1 Valves on all main piping circuits.

.2 Valves on all major branch lines.

.3 Valves on minor branch lines in horizontal service spaces, vertical service spaces and mechanical equipment rooms.

.4 Drain valves and hose bibbs on systems containing glycol.

.5 Control valves.

.6 DO NOT TAG valves on control valve stations, steam trap stations, fixture stops, system drain valves.

.3 Schedule the valve numbers using a sequential numbering system indicating location, service and normal position (open or closed).

1.4 DUCTWORK

.1 Identify plenum access doors as to accessed items, e.g. Filter F-1, Supply Fan SF-1, Heating Coil HC-1.

.2 Stencil on all plenum doors, downstream from air filter bank. "Do not open when fan operating".

.3 Identify all ductwork in mechanical equipment rooms to denote system and/or zone served and an air flow direction arrow.

.4 Identify automatic control dampers concealed in ductwork. Identify the "open" and "closed" position of the operator arm on the outside of the duct or duct insulation.

.5 Identification letters shall be 50 mm [2"] high black letters on white background. Flow arrows shall be 50 mm [2"] wide by 150 mm [6"] long black arrows on a white background. Stencil over final finish only.

1.5 CEILING ACCESS

.1 Secure 6 mm [1/4"] self adhesive coloured dots, (Brady Quik Dots or Avery Data Dots, or equivalent), to the ceiling, to identify the location of access to equipment concealed above the ceiling according to the following schedule:

	Colour
Concealed equipment and cleaning access	Yellow
Control equipment, including control valves, dampers and heat sensors	Black
Fire, smoke and sprinkler equipment	Red
Pipe mounted equipment, other than fire, smoke and sprinkler equipment	Green

.2 When T-bar ceilings are installed adhere coloured dots to T-bar framing, adjacent to panel to be removed.

1.6 DUCT ACCESS

.1 Secure 50 mm [2"] high, Gothic style self-adhesive stick on-letters, (Letrasign or Brady Quick-Align, or equivalent) on duct access panels to identify their usage, according to the following schedule:

	Colour	**Letters**
Cleaning and service access	Black	C.A
Controls including heat sensors	Black	C
Dampers, (backdraft, balance and control)	Black	D
Fire dampers	Red	F.D
Smoke dampers and detectors	Red	S.D

1.7 TAGGING IDENTIFICATION

.1 Secure engraved laminated plastic identification tags (black face and white centre) on the following items:

.1 Temperature control instruments, gauges and panels, coordinated with control diagrams identification.

.2 Electrical switchgear supplied under Division 23.

1.8 PIPE IDENTIFICATION COLOUR SCHEDULE

Service	Identification Lettering	Primary Colour	Secondary Colour
Cold Water Service	C.W.	green	-
Combined standpipes	C.S.	red	white
Domestic H.W. Recirc.	D.H.W.R.	yellow	black
Domestic H.W. Supply	D.H.W.S.	yellow	black
60oC [140oF]	60°C [140°F]		
Fire lines W.S.	W.S.	red	white
Hot Water Return	H.W.R.	yellow	black
Hot Water Supply	H.W.S.	yellow	black
Natural Gas	Gas	yellow	orange
Sprinkler lines	S.P.R.	red	white
Chilled water supply	CHWS	yellow	green
Chilled water return	CHWR	yellow	green
Glycol system	_ _ _ _ - GL		black

1.9 PIPE IDENTIFICATION BANDING COLOURS

.1 LETTERS:

.1 13 mm [1/2"] high - 1-1/4 NPS pipe & smaller.

.2 25 mm [1"] high - 1-1/2 NPS up to 2-1/2 NPS pipe.

.3 50 mm [2"] high - 3 NPS and larger pipe.

.2 BANDS:

.1 38 mm [1-1/2"] wide, except arrow bands 50 mm [2"] wide.

.3 COLOURS:

.1 horizontally hatched - primary colour.

.2 vertically hatched - secondary colour.

.3 black letters and arrows on yellow primary colour.

.4 background, white letters and arrows or red, blue or green backgrounds.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

.1 Section 01 91 31 – Commissioning Plan.

.2 Section 01 91 33 – Commissioning Forms.

.3 Section 01 91 41 – Commissioning Training.

.4 Section 23 08 00 – Mechanical Commissioning.

.5 Section 23 08 01 – Performance Verification.

1.2 TESTS

.1 Give written 72-hour notice of date for tests.

.2 Do not externally insulate or conceal work until tested and approve. Follow construction schedule and arrange for tests.

.3 Conduct tests in presence of Departmental Representative. Arrange for the Departmental Representative to be present.

.4 Bear costs including retesting and making good.

.5 Refer to Piping Sections for specific test requirements.

.6 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

1.3 BALANCING - AIR SYSTEMS

.1 Adjust duct and terminal balance dampers and adjust or change drive sheaves to balance supply, return and exhaust air systems to provide the design air quantities (within +/- 10%) at each outlet and inlet and to maintain the design relationship between the supply and exhaust air system quantities.

.2 Adjust air terminals to obtain the optimum air distribution pattern.

.3 Permanently mark the final balance position on all balance dampers and adjustable air turning devices by means of permanent custom adhesive stickers across the balancing dampers to seal them in position.

.4 Submit a report to the Departmental Representative indicating final fan r/min., motor operating amperages, system static pressure and final air quantities obtained.

.5 Air systems shall be balanced with clean filters in place, at a total of 105% to 110% of specified total airflow rates.

1.4 BALANCING - LIQUID SYSTEMS

.1 Balance liquid systems using a surface temperature measuring instrument such as Alnor pyrometer or a flow meter if installed. Adjust balance valves and balance fittings to obtain design flow rates or uniform temperature differences (on the liquid side) across coils and heating/cooling elements acknowledging the specified temperature drops and rises on the air and water side. Measure liquid flow rates. Liquid systems include:

.1 Hot water heating systems, adjust and mark all balance valves.

.2 Chilled water systems, adjust and mark all balance valves.

.3 Domestic hot water systems, adjust and mark all balance valves.

.2 Permanently mark the final balance position on balance valves and balance fittings and lock memory stops.

.3 Adjust pump speeds and update setpoints.

.4 Submit a report to the Departmental Representative indicating the final temperatures obtained.

1.5 TESTING AND BALANCING

.1 Employ a qualified independent testing and balancing agency to test and balance the following systems. Prior to finalizing contractual arrangements with the balancing agency, submit the names, qualifications and years of direct field testing and balancing experience in the testing and balancing field for all members of the balancing team that is scheduled to carry out the balancing work. The senior site technologist must have a minimum of five years testing and balancing experience of similar projects. Provide a list of a minimum of ten comparable projects successfully completed by all key members of the balancing team.

.1 Heating hot water system(s).

.2 Supply air system(s).

.3 Return air system(s).

.4 Exhaust air system(s).

.5 Emergency smoke/gas evacuation system(s).

.6 Existing systems.

.7 Chilled water system.

.8 Heat pump (source/load) loop system.

.9 Make-up air system.

.10 Tear gas system.

.11 Domestic hot water system.

.2 The Agency shall be responsible to the Contractor but report jointly to the Departmental Representative and the Contractor. Report in writing to the Departmental Representative any lack of cooperation and any discrepancies or items not installed in accordance with the contract documents.

.3 Procedures shall be in general accordance with AABC'S National Standards for Field Measurement and Instrumentation and ASHRAE Standards.

.4 The balancing agency shall agree to perform spot checks, where requested, in the presence of the Departmental Representative 's designated representative.

.5 Work with the agency to:

.1 Ensure that all mechanical systems are complete and ready to be balanced and provide sufficient time for testing and balancing prior to substantial performance.

.2 Make corrections to achieve system balance without delay, include all corrections made during the balancing procedure on "As Built" Drawings. Mechanical Contractor to provide “As Built” information to the balancing agency before balancing commences.

.3 Adjust fan drives, change blade pitch angles and change sheaves and belts as directed by the agency.

.4 Maintain all systems in full operation during the complete testing and balancing period.

.5 Employ control technicians to make adjustments to the control systems to facilitate the balancing process.

.6 Employ the journeyman millwright to check the alignment of any V-belt drives and/or shaft coupling drives if they have been adjusted during the balancing process. Belt tension correctness to be verified.

.6 Consult with the Departmental Representative to clarify the design intent where necessary or in case there are any problems foreseen as the balancing processes.

.7 Complete air balance before commencing water balance where heating/cooling coils are installed in the air system. Balancing shall not commence until systems have been cleaned and treated and the air removed from within the piping systems.

.8 Accuracy: Balance to maximum flow deviation of 10% at terminal device and to 5% at equipment. Measurements to be accurate to within plus or minus 5% of actual values.

.9 Instrument calibration: At the Departmental Representatives request, the balancing agency shall submit a dated calibration chart for all instruments.

.10 Permanently mark final settings on valves, dampers and other adjustment devices. Set and lock all memory stop balancing devices.

.11 Seal all holes with snap plugs or approved alternate method, used for flow and pressure measurements.

.12 The controls contractor and balancing agency are to allow for checking and making adjustments during the 12 month warranty period, when weather conditions provide natural loads and in cases where complaints arise.

.13 Submit a draft balance report to the Departmental Representative for approval and submit approved copies to the agency preparing the O & M manuals for inclusion in each operating and maintenance manual. Provide field notes in the balancing report to clearly identify unusual conditions, problem areas and report on any cases where the specified flow rates or conditions could not be achieved by adjustment. Identify outstanding problems that cannot be corrected by the balancing team or that will not be corrected by the installing trades (e.g. in cases where additional balancing dampers are required).

.14 Submit a statutory declaration to the Departmental Representative, certifying that the testing and balancing procedures have been completed, that complete factual reports have been distributed and that directions have been given to the Contractor to correct faults and omissions and, finally, that follow-up testing, after correction of faults and omissions, has been completed and recorded. Form MF170 in Section 23 06 02 should be used for this purpose. Reports to be signed by the senior member of the balancing team.

.15 Employ the testing and balancing agency to test all fire dampers as follows:

.1 Test all fire dampers (including combination smoke/fire dampers). The test shall be made by releasing the fusible link and witnessing closure of the damper. All fire dampers shall be left in the open position.

.2 A set of prints shall be marked up to show that each damper has checked for closure, accessibility and installation or provide schematic mechanical drawing showing all fire damper locations, label all fire dampers on drawing and reference to form MF172. The prints shall be certified correct by the agency and submitted to the Departmental Representative with completed test certificate MF172.

1.6 AIR SYSTEMS - BALANCING

.1 Adjust duct and terminal balance dampers, and adjust or change drive sheaves and fan blade pitch angles to obtain design quantities (within +/- 10%) at each outlet and inlet.

.2 Use terminal balance dampers to regulate air quantities only to the extent that adjustments do not create objectional air motion or sound levels. The sheet metal sub contractor shall provide additional dampers where required by the balancing agency to achieve a satisfactory balance without creating noise problems.

.3 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross-sectional area of duct. Provide a pitot tube traverse test sheet for each major duct branch.

.4 Measure air quantities at each air terminal.

.5 Maintain the design relationship between the supply and exhaust air system quantities.

.6 Check to ensure that supply and return air quantities provide reasonable building pressurization. Test building pressurization levels in variable volume systems throughout full range of fan delivery rates, under both heating and cooling conditions. Exit doors and elevator shafts should be checked for air flow so that exterior conditions do not cause excessive or abnormal pressure conditions. Document abnormal building leakage conditions noted.

.7 Adjust the air terminals to obtain the optimum air distribution pattern. The total airflow through each air valve should be adjusted and reported by the balancing agency for maximum and minimum flow conditions.

.8 Controllers on air valves are to be checked by the controls contractor and the commissioning agent and they shall also verify that room thermostats / sensors are cycling valves properly.

.9 Air systems shall be balanced with clean filters in place, at a total of 105% to 110% of specified total airflow rates.

.10 Where variable air volume systems are installed, take measurements at maximum and minimum flows. Record the minimum operating duct static pressure setpoint for each air handling system.

.11 In conjunction with the Controls Contractor set and verify the outdoor air damper minimum position. The balancing agent shall measure the O/A volume during minimum O/A condition when the air valves/mixing boxes are at a simulated minimum system condition.

.12 Balance all air systems for 100% outdoor air and 100% relief air. Upon completion of each system balance, check to ensure that the fan motor does not overload and that the main duct pressure does not change substantially when the system is switched over to minimum O/A condition.

.13 The Balancing Agency shall include for [3] days of return visits for readjustment of systems after substantial completion.

.14 Include in the air balance report:

.1 Date of test, Name and address of building and balancing technician's name.

.2 Range of outdoor air temperature during the balancing period.

.3 System schematics indicating damper positions, design and measured air quantities at each inlet and outlet. Show room numbers and floors.

.4 If installation permits, record both air terminals and fan discharge traverse air volumes to establish system leakage.

.5 Main branch duct traverses. Maximum and minimum outdoor air quantities.

.6 Static pressure across each component in an air handling system at full flow.

.7 Face velocities across major components such as filter or coils.

.8 Static pressure across each fan.

.9 System static pressures at selected points throughout a VAV supply duct system and in main branch ducts in low velocity systems.

.10 Fan and motor speed.

.11 Motor size, starting time, amps and voltage.

.12 Coil air entering and leaving temperatures (D.B. and W.B.).

.13 Maximum and minimum zone supply air temperatures under prevailing conditions at time of test.

.14 Provide fan performance curve for each new air handling system.

1.7 LIQUID SYSTEMS – BALANCING

.1 Set balance valves and balance fittings to provide required or design flow rates for each system component.

.2 Use installed flow measuring devices to determine flow rates for system balance. Where flow measuring devices are not installed, base flow balance on the air and liquid temperature difference across terminal heating/cooling elements and coils, acknowledging the different design temperature drops/rises used in the design of the systems.

.3 Effect system balance with automatic control valves fully open to heat transfer elements.

.4 Trim pump impellors to match pump performance to system characteristics rather than artificially increasing system pressure drops to match pump characteristics.

.5 Check air vents to ensure that they are correctly installed and are operating properly. The mechanical contractor shall ensure that all air is removed from within the piping system and that there is flow throughout all piping systems before the balancing is started.

.6 Include in the liquid balance report:

.1 Date of test, Name, and address of building and balancing technician's name.

.2 Range of outdoor air temperature during the balancing procedure.

.3 Pumps: Tag, service, location, manufacturer, model and size. Specified and actual flow and head pressure. Motor size, speed, amps and voltage.

.4 Heat Exchangers: Tag, service, location, manufacturer, model and size. Specified and actual capacity, liquid flow rates (tube & shell), inlet & outlet temperatures (tube & shell) & inlet steam pressure (if applicable).

.5 Heating/Cooling Coils: Tag, service & location. Specified and actual capacity, flow, liquid pressure drop, liquid entering and leaving temperatures, air-side entering and leaving temperatures.

.6 Flow measuring devices: Flow rates.

.7 Terminal heating/cooling elements: Entering and leaving liquid temperatures.

.8 System schematics: Specified and actual flow rates.

.9 Provide pump performance curve for each new pump system.

1.8 OPERATING AND MAINTENANCE MANUALS

.1 Refer to Section 01 78 00 for supplemental or more stringent requirements to those listed below.

.2 Employ an approved independent contractor specializing in operating and maintenance manuals to prepare instruction manuals covering the operation and maintenance of the mechanical systems and equipment installed under this contract.

.3 Request the manufacturer’s brochures at the time of equipment purchase. Forward all necessary data including approved shop drawings and manufacturer’s brochures to the Agency for inclusion in the Manual.

.4 Instructions shall be clearly written in language easily understood by the Operating and Maintenance personnel. Include only specific information pertinent to the equipment installed. Advertising literature and brochures of a general nature will be rejected.

.5 A front title page shall identify the Project, the Prime Consultant and the

Mechanical Consultant, other relevant Consultants. In addition, the names of the General Contractor, Mechanical, Sheetmetal, Control and Sprinkler Sub-Contractors, with addresses and telephone numbers shall be listed.

.6 An index shall be provided and the manual shall be divided by index dividers including but not limited to the following major sections:

.1 Systems Description

.1 Comprehensive description of the operation of each system including the function of each item of equipment within the systems and all reset schedules and seasonal adjustments.

.2 Include a schematic drawing and component description for each major mechanical system including air handling systems, boiler and hot water heating piping distribution systems.

.3 The schematic drawing shall identify each component with a letter designation corresponding to a description briefly explaining the purpose of each component and how it relates to the other components, and be presented in a current version of AutoCAD or similar computer aided drafting program.

.4 Description of actions to be taken in event of equipment failure.

.2 Maintenance and Lubrication

.1 Maintenance schedules including detailed servicing, maintenance and trouble-shooting instructions for each item of equipment including daily, weekly, monthly, semi-annual and annual checks and tasks.

.2 Lubrication schedules, indicating recommended lubricants and grades (grease or oil) for all lubricated equipment components.

.3 Manufacturer's technical literature for each item of equipment installed. Literature shall include: Operating instructions, Maintenance instructions, Wiring Diagrams, Parts list and Installation instructions, Ventilation requirements, Energy considerations, Automatic temperature control settings, Information regarding air filters and pressure drops for clean and dirty conditions., Trouble Shooting Procedure Guide in spreadsheet form with the most likely causes and recommended actions for all foreseeable problems. Trouble Shooting Procedure guides are required for all the major items of equipment including air handling systems, exhaust

fans, circulating pumps, mechanical cooling equipment, etc., and Mechanical Equipment Starting Procedures.

.3 Equipment Suppliers

.1 Local source of supply for replacement parts for each item of equipment.

.4 Balancing Reports

.1 Air system balance report.

.2 Water system balancing report.

.5 Electrical Switchgear

.1 Electrical switchgear schedule, indicating circuit number, panel location and disconnect location for each item of equipment.

.6 Shop Drawings

.1 Copies of all "reviewed" shop drawings including fan and pump performance data including performance curves with the operating point indicated. Shop drawings shall be c/w Departmental Representatives review form.

.2 Plumbing fixture brochure.

.3 In addition to the shop drawings provided for the various items of mechanical equipment, this section shall also include the Manufacturers' Literature on:

.1 Operating and maintenance instructions

.2 Spare parts lists

.3 Trouble Shooting information.

.7 Schedules

.1 Belt schedule, indicating size and number of belts required.

.2 Labelling and identification schedules including colour coding.

.3 Valve schedule, including location, service, normal position and area served.

.4 Air filter schedule indicating model no, size, number of filters required and servicing instructions (i.e.) static pressure readings, etc. for each filter bank.

.8 Guarantees, Certificates and Miscellaneous Reports

.1 Boiler Inspection - Certificate of Approval.

.2 Buried gas pipe covering test report.

.3 Back flow device test reports.

.4 Checklists for start-up (MF151, 152,153).

.5 Certificate of Testing and Balancing (MF170).

.6 Certificate of Duct Cleanliness (MF171).

.7 Certificate of Fire Damper Installation (MF172).

.8 Certificate of Penetrations through separations (MF173).

.9 Certificate of Seismic Restraint Installation (MF174).

.10 Certificate of Vibration Isolation Installation (MF175).

.11 Checklists for Demonstrations (MF181, 182, 183).

.12 Certificate of Substantial Performance (MF190).

.13 Chemical cleaning and treatment report for piping systems.

.14 Chlorination report for water mains.

.15 Millwright setting and alignment certificate.

.16 Commissioning reports/checklists.

.17 Duct leakage test reports.

.18 Equipment performance test results (e.g. chiller).

.19 Extended warranty certificates.

.20 Gas Inspection - Certificate of inspection.

.21 Sprinkler flushing certificates.

.22 Sprinkler Contractor's materials and test certificate.

.23 Plumbing inspection certificate.

.9 Control Systems

.1 Descriptive sequence of operation of automatic control system, with "as-built" control schematics indicating the final settings.

.2 Control equipment maintenance bulletins.

.3 Interlock wiring diagrams.

.7 Submit a draft copy of the Manual to the Departmental Representative for approval, two weeks prior to start-up of the systems and equipment.

.8 After receiving approval of the draft copy, make any corrections as may be required and then furnish three final copies to the Departmental Representative at least ten days prior to the substantial performance inspection date. Provide more than one volume if the overall thickness of a single binder would exceed 100 mm [4"].

.9 Printed hard cover manuals shall be supplied in 3 post hard back Acco expansion style "Fliplock" binders (or equivalent), with stamped lettering on the front cover and spine showing the following:

.1 Name of Project

.2 Name of Manual - "Operating and Maintenance Manual Mechanical Systems"

.3 Volume - "X" of "Y"

.10 Digital manuals shall be supplied on three CD-ROMs in digital format. The information shall be organized into sections in a user-friendly format that is easy to search for specific information. An indexing system shall be included that remains on an expandable portion of the screen and allows the end user to scroll through the manual information that appears on the main portion of the screen. The digital version content and organization for each manual shall be arranged in a manner identical to the hard copy version. The specific requirements are listed below:

.1 Utilize Adobe Acrobat Portable Document Format (PDF).

.2 If there is more than one volume of manual, indicate “Volume X of Y” for each volume.

.3 The final Digital copies are to be copied to CD media with a custom CD label.

.4 The custom CD label shall include: Project Name, Location of Project, Date of Assembly, name of Mechanical Consultant, and shall be titled “Operating & Maintenance Manual for Mechanical Systems”.

.5 The Digital Manual shall be enhanced with the following features: Bookmarks, Internet Links, Internal Document Links and Optical Character Recognition (OCR). Refer to Scanning Requirements and Organizational Requirements listed below.

.6 Scanning Requirements:

.1 All pages contained within the hard copy manual are to be scanned and/or digitized to Adobe Acrobat PDF.

.2 Provide a minimum 300 DPI for all scanned pages.

.3 All scanned material may be searched for text with minimum 60% Optical Character Recognition (OCR).

.4 All scanned shop drawings are to be scanned to a minimum 8.5”X11” size. If the original page size is 11”X17”, the digital copy shall also be 11”X17”.

.5 Rotation of scanned page images/texts shall be displayed within +/- 20 degrees.

.7 Organizational Requirements:

.1 Digital Manual shall be organized in the same manner as the approved Hard Copy Manual. (e.g. Tabs 1.1, 1.2, 1.3, 2.0, 3.0, etc)

.2 Bookmark all major tabs and subsections

.3 Bookmark each set of shop drawings

.4 Link the Table of Contents page to the referenced sections

.5 Insert an introduction / summary page for all sections indicating major subsections. Link these pages to their referenced sections

.6 Link the system descriptions to the referenced schematic drawings.

.7 Insert internet links and internal document links to mechanical equipment manufacturers / suppliers / contractor's official websites; and to mechanical equipment shop drawings.

.8 It is the responsibility of the mechanical contractor to provide high quality documentation for scanning.

.9 The digital version of the manuals and the hard cover version shall be prepared by the same company.

.10 Digital Manual shall be reviewed by the Departmental Representative for content and layout prior to final submission.

.11 All information within the hard copy manual shall be included within the Digital Manual. At the Departmental Representative's discretion the following exceptions may be made so that the manual may be available for use at an earlier date:

.1 The final Balance Report may be provided as a later submission in Adobe Acrobat PDF. In this case, Balance Report(s) may be kept separate from the Digital Manual.

.2 The final Commissioning Report may be provided as a later submission in Adobe Acrobat PDF. In this case, the Commissioning Report(s) may be kept separate from the Digital Manual.

.11 Manuals shall be supplied in three post Acco expansion style "Fliplock" binders (or equivalent), with clear window label insert on front cover and indicating Name of Project and Name of Manual.

END OF SECTION

TABLE OF CONTENTS

Sched # MS160

UNIT NO	**B -01**	**B -02**
OUTPUT (kW)	418	418
(MBH)	1425	1425
FLOW (L/s)	7.6	7.6
(USGPM)	120	120
PRESSURE:		
DESIGN (kPa)	517	517
(PSI)	75	75
OPERATING (kPa)	172	172
(PSI)	25.00	25.00
HI-LIMIT (kPa)	186	186
(PSI)	27	27
RELIEF (kPa)	207	207
(PSI)	30	30
TEMPERATURE:		
OPERATING (C)	82.22	82.22
(F)	180.00	180.00
HI-LIMIT (C)	121.11	121.11
(F)	250.00	250.00
FUEL:		
PRIMARY	Nat.Gas	Nat.Gas
IGNITION	Electronic	Electronic
BURNER CONTROL:		
PRIMARY	Nat.Gas	Nat.Gas
GAS FLOW (cu m/h)	42	42
(cu Ft/h)	1500	1500
GAS PRESS. (kPa)	34.5	34.5
(psig)	5	5
ELECT.POWER (Amps)	12.00	12.00
VOLTS/PHASE/Hz	208/1/60	208/1/60
MANUFACTURER	PK	PK
MODEL NO.	N-1500-MFD	N-1500-MFD
SEE NOTE(S):	All	All

Notes:
1. 6:1 Turndown, modulating gas train, modulating controls
2. Package to include boiler pump and venting
3. Neutralizer package
4. Separate circuit (120V) for controller

Sched # MS182

UNIT NO	**CH -1**
LOCATION	Roof
CAPACITY (kW)	88
(TONS)	25
EVAPORATOR:	
FLOW (L/s)	3.79
(GPM)	60
P.D. (kPa)	45
(Ft)	15.00
EWT (C)	12.22
(F)	54.00
LWT (C)	6.67
(F)	44.00
FOUL. ALLOW.	0.0001
NO PASSES	1
CONDENSER:	
NO OF FANS	4
AIR FLOW (L/s)	0
(CFM)	
EAT (C)	35.00
(F)	95.00
Min EAT (C)	7.2
(F)	45.00
COMPRESSOR:	
NO OF UNITS	4
CAPACITY STEPS	4
REFRIGERANT	R 410A
ELECT.POWER (kW)	MCA=45
VOLTS/PHASE/Hz	575/3/60
MANUFACTURER	Multistack
MODEL NO	(1) ASP010XC - (1) ASP015XC
SEE NOTE(S)	All

Notes:
1. Modular scroll air cooled chiller (with freeze protection)
2. Single point power connection
3. BACnet interface
4. Multiple, independent refrigeration systems (2 modules, 2 compressors per module)
5. MCA=45A; MOP=60A; separate circuit for heat trace (120V, 14 MCA, 20 MOP)
6. Refer to specification for additional options and accessories

Sched # MS240 **CONDENSING UNITS - AIR COOLED**

UNIT NO	**CU -101**	**CU -102**	**CU -103**	**CU -104**
SERVICE	FCU-101	FCU-102	FCU-103	FCU-104
LOCATION	Roof	Roof	Roof	Roof
CAPACITY (kW)	15.24	15.24	8.79	8.79
(BTUh)	52000	52000	30000	30000
EVAP.TEMP.(C)	6.67	6.67	6.67	6.67
(F)	44.00	44.00	44.00	44.00
COND.TEMP.(C)	40.56	40.56	40.56	40.56
(F)	105.00	105.00	105.00	105.00
REFRIGERANT	R 410A	R 410A	R 410A	R 410A
CONDENSER FAN:				
AIR FLOW (L/s)	1,835	1,835	1,835	1,835
(CFM)	3,885	3,885	3,885	3,885
FAN MOTOR (HP)	0.20	0.20	0.20	0.20
AMBIENT AIR:				
MAX TEMP. (C)	35.00	35.00	35.00	35.00
(F)	95.00	95.00	95.00	95.00
MIN TEMP. (C)	-18.0	-18.0	-18.0	-18.0
(F)	0.00	0.00	0.00	0.00
ELECT.POWER (kW)	34.0 MCA	34.0 MCA	23.0 MCA	23.0 MCA
VOLTS/PHASE/Hz	208/3/60	208/3/60	208/3/60	208/3/60
MANUFACTURER	Trane	Trane	Trane	Trane
MODEL NO	4TVH0053 B100NC	4TVH0053 B100NC	4TVH0036 B100NC	4TVH0036 B100NC
SEE NOTE(S)	1, 2, 3	1, 2, 3	1, 2, 3	1, 2, 3

Notes:
1. Coordinate and select with respective fan coil unit
2. Communication kit and BACnet interface
3. Windbreak – enables operation to -18°C [0°F]
4. Refer to specifications for additional requirements and accessories

Sched # MS 279

UNIT NO	**CV - HX1**	**CV - HX2**	**SV - DHW**
SERVICE	Heat Exchanger	Heat Exchanger	DHW drain
MEDIUM	Water	Water	Water
CAPACITY (L/s)	3.25	3.25	0.13
(GPM)	51.50	51.50	2
TYPE	2M	2M	2P
MAX P.D. (kPa)	36	36	70
(Ft)	12	12	23
CV	22.6	22.6	0.63
NORMAL POSITION	NC	NC	NC

VALVE TYPE:
2M - 2-WAY MODULATING
2P - 2-WAY 2 POSITION
3M - 3-WAY MODULATING
3D - 3-WAY DIVERTING

Sched #
MS341

FAN COIL UNITS - REFRIGERANT

UNIT NO	**FCU -101**	**FCU -102**	**FCU -103**	**FCU -104**
SERVICE	Rm 2802/2803	Rm 2802/2803	Rm 2800/2801	Rm 2800/2801
TYPE	Vertical	Vertical	Vertical	Vertical
LOCATION	Mech. Room.	Mech. Room.	Mech. Room.	Mech. Room.
COOLING:				
TOTAL (kW)	15.24	15.24	8.79	8.79
(BTUh)	52000	52000	30000	30000
SENS. (kW)	14.66	14.66	8.50	8.50
(BTUh)	50000	50000	29000	29000
EDB. (C)	26.67	26.67	25.56	25.56
(F)	80.00	80.00	78.00	78.00
EWB. (C)	18.33	18.33	18.33	18.33
(F)	65.00	65.00	65.00	65.00
LDB. (C)	12.78	12.78	12.78	12.78
(F)	55.00	55.00	55.00	55.00
LWB. (C)	12.22	12.22	12.22	12.22
(F)	54.00	54.00	54.00	54.00
COIL REFRIG.(C)	7.22	7.22	7.22	7.22
(F)	45.00	45.00	45.00	45.00
REFRIGERANT	R 410A	R 410A	R 410A	R 410A
SUPPLY FAN:				
FLOW (L/s)	849	849	849	849
(CFM)	1800	1800	1800	1800
EXT.S.P.(Pa)	62	62	62	62
(ins)	0.25	0.25	0.25	0.25
FAN MOTOR (HP)	0.75	0.75	0.75	0.75
VOLTS/PHASE/Hz	208 / 1 / 60	208 / 1 / 60	208 / 1 / 60	208 / 1 / 60
MANUFACTURER	TCS	TCS	TCS	TCS
MODEL NO	C2-B-022	C2-B-022	C2-B-022	C2-B-022
SEE NOTE(S)	All	All	All	All

Notes:
1. Replace existing (water cooled) fan coil units - take field measurements
2. Match existing Cabinet size
3. Coordinate and interface with corresponding Condensing Unit
4. Refer to specifications for additional requirements and accessories

Sched # MS400 **HEAT EXCHANGERS - LIQUID**

UNIT NO	**HE - 1**	**HE - 2**
SERVICE	DHW	DHW
LOCATION	Boiler Room	Boiler Room
CAPACITY (kW)	146.55	146.55
(MBH)	500	500
HEATING SIDE:		
LIQUID TYPE	Water	Water
GLYCOL(%)	0.00	0.00
FLOW (L/s)	3.22	3.22
(GPM)	51.03	51.03
ENT. (C)	76.67	76.67
(F)	170.00	170.00
LVG. (C)	65.56	65.56
(F)	150.00	150.00
P.D. (kPa)	42	42
(Ft)	14.00	14.00
HEATED SIDE:		
LIQUID TYPE	Potable Water	Potable Water
GLYCOL(%)		
FLOW (L/s)	0.61	0.61
(GPM)	9.60	9.60
ENT. (C)	4.44	4.44
(F)	40.00	40.00
LVG. (C)	62.78	62.78
(F)	145.00	145.00
P.D. (kPa)	3	3
(Ft)	1.00	1.00
FOUL. ALLOW (%)	0.001	0.001
DIMENSIONS:		
HTG.AREA (sq m)	2.14	2.14
(sq Ft)	23.00	23.00
HEIGHT (mm)	406	406
(ins)	16	16
WIDTH (mm)	254	254
(ins)	10	10
MANUFACTURER	SWEP	SWEP
MODEL NO	B35TDWM4x24/1P	B35TDWM4x24/1P
SEE NOTE(S)	1, 2, 3	1, 2, 3

Notes:
1. Rated for Domestic Hot Water / Double wall construction
2. Brazed plate heat exchanger
3. Provide supporting frame / stand

Sched # MS500a

PUMPS

UNIT NO	**P -101 DHW**	**P -102 DHW**	**P -101 CHWN**	**P -102 CHWN**
SERVICE	DHW	DHW	CHW	CHW
LOCATION	Boiler Room	Boiler Room	Boiler Room	Boiler Room
PUMP TYPE	Circulator	Circulator		
CAPACITY (L/s)	0.61	0.61	3.79	3.79
(GPM)	9.7	9.7	60.00	60.00
LIQUID:				
WATER	Potable	Potable	Water	Water
GLYCOL (%)	0	0	0	0
LIQUID TEMP. (C)	60.00	60.00	23.89	23.89
(F)	140.00	140.00	75.00	75.00
DIFF.PRESS. (kPa)	105	105	224	224
(Ft)	35	35	75	75
MIN. EFFIC. (%)				
IMPELLOR DIA.				
(mm)	0	0	0	0
(ins)				
PUMP (r/min)				
PUMP MOTOR (HP)	0.5	0.5	5	5
VOLTS/PHASE/Hz	120/1/60	120/1/60	575/3/60	575/3/60
MANUFACTURER	Armstrong	Armstrong	Armstrong	Armstrong
MODEL NO	E12.2B	E12.2B	2 x 2 x 10	2 x 2 x 10
SERIES			4380	4380
SEE NOTE(S)	1,	1,	2, 3	2, 3

Notes:

1. All bronze - rated for potable water
2. Replacement Chilled water pump
3.

Sched # MS500b

PUMPS

UNIT NO	**P -103 DHW**	**P -104 DHW**	**P -B101**	**P -B102**
SERVICE	DHW	DHW	B101	B102
LOCATION	Boiler Room	Boiler Room	Boiler Room	Boiler Room
PUMP TYPE	Circulator	Circulator		
CAPACITY (L/s)	0.63	0.63	7.6	7.6
(GPM)	10.00	10.00	120	120
LIQUID: WATER	Potable	Potable	Water	Water
GLYCOL (%)	0	0	0	0
LIQUID TEMP. (C)	60.00	60.00	90.6	90.6
(F)	140.00	140.00	195	195
DIFF.PRESS. (kPa)	105	105	55	55
(Ft)	25	25	18	18
MIN. EFFIC. (%)				
IMPELLOR DIA. (mm) (ins)	0	0	0	0
PUMP (r/min)				
PUMP MOTOR (HP)			1.5	1.5
VOLTS/PHASE/Hz	120/1/60	120/1/60	575/3/60	575/3/60
MANUFACTURER	Grundfos	Grundfos	Armstrong	Armstrong
MODEL NO			3D	3D
SERIES			4360	4360
SEE NOTE(S)	1, 3, 4	1, 3, 4		

Notes:

1. All bronze - rated for potable water
2. Replacement Chilled water pump
3. Variable speed, integral variable speed drive, ECM motor
4. Replace existing DHW recirculation pumps; match existing

Sched # MS540

UNIT NO	**ET -DHW**
SERVICE	DHW
LOCATION	Mech. Space
WK.PRESS. (kPa)	586
(PSI)	85
CAPACITY (L)	249
(US Gals)	66
TANK DIMENSIONS:	
DIAMETER (mm)	610
(ins)	24
LENGTH (mm)	1219
(ins)	48
ARRANGEMENT	Vertical
MANUFACTURER	Amtrol
MODEL NO	ST-120V-C
SEE NOTE(S)	All

Notes:
1. Rated for potable water
2. Expansion Volume: 95 L [25 USGal]
3. Fill Pressure: 350 kPa [50 psi]

END OF SECTION

Part 1 Mechanical Forms

1.1 MF 100 CHECKLIST – SUBMISSIONS TO ENGINEER

ITEM	CHECKED BY	DATE
10 WORKING DAYS BEFORE CLOSE OF SUBTRADE TENDER – Request for addition of acceptable manufacturers		
10 DAYS AFTER AWARD OF THE CONTRACT – List of equipment suppliers and subtrades – Detailed price breakdown (MF 120, 121, 122)		
A.S.A.P. – Product & Fabrication samples (MF 131) – Shop Drawings		
WITH EACH APPLICATION FOR PROGRESS PAYMENT – Price breakdown (MF 120, 121, 122)		
PRIOR TO CLOSING IN CEILINGS & SHAFTS – Duct and pipe test data		
PRIOR TO STARTING SYSTEMS – Checklists for start-up (MF 151, 152, 153)		
PRIOR TO COMMISSIONING SYSTEMS – Checklists for operation (MF 151, 152, 153) – Commissioning schedule		
PRIOR TO DEMONSTRATION OF SYSTEMS – Demonstration agenda		
10 DAYS PRIOR TO SUBSTANTIAL PERFORMANCE INSPECTION – Submission of items listed on Form MF-188		
WHEN REQUESTING INSPECTION OF OUTSTANDING WORK – Certificate of total completion (MF 192) – Checklist of work remaining (MF 191) – Checklists of Demonstrations (MF 181, 182, 183)		

1.2 MF 151 Checklist - Start-up and Operation Requirements - Air Systems

System: _____

ITEM	CHECKED BY	DATE
Prior To Start-Up Safety Controls Installed & Operational Control And Smoke Dampers Operational Permanent Electrical Connections Made Fan Drives Aligned By Millwright Fan Rooms & Plenums Vacuum Cleaned Equipment Lubricated Building Swept & Clear Of Dust All Filters Installed Operating & Maintenance Data Available		
During Start-Up Qualified Operator In Charge Supply Ducts Blown Out Using Fans		
During Subsequent Operation Qualified Operator In Charge Ensure That The Building Has Remained Clean Equipment Maintained Lubrication Maintained & Logged		

NOTES:

.1 This is a brief checklist and does not cover all procedures which may be advisable in a particular case.
Additional information is available from equipment suppliers.

.2 Prior to starting or operating each system complete the appropriate section of this form and submit it to the Departmental Representative.

.3 Submit completed copies of this form for each system with the certificate of substantial performance.

1.3 MF 152 Checklist - Start-up and Operation Requirements – Water Systems

System: _____

ITEM	CHECKED BY	DATE
Prior To Start-Up Safety Controls Installed & Operational Permanent Electrical Connections Made Equipment Lubricated System Flushed Out Operating & Maintenance Data Available Boiler Inspector Notified Chemical Treatment Agency Notified		
During Start-Up Qualified Operator In Charge Rooftop units Manufacturer's Rep. present		
Prior to Operation Boiler inspectors Approval Obtained Report from Chemical Treatment Agency Submitted		
During Operation Qualified Operator In Charge Equipment Maintained Lubrication Maintained & Logged		

NOTES:

.1 This is a brief checklist and does not cover all procedures which may be advisable in a particular case.
Additional information is available from equipment suppliers.

.2 Prior to starting or operating each system complete the appropriate section of this form and submit it to the Departmental Representative.

.3 Submit completed copies of this form for each system with the certificate of substantial performance.

1.4 MF 153 Checklist - Start-up and Operation Requirements – Refrigeration Systems

System: _____

ITEM	CHECKED BY	DATE
Prior To Start-Up Safety Controls Installed & Operational Permanent Electrical Connections Made Equipment Lubricated System Charged and Tested Operating & Maintenance Data		
During Start-Up Qualified Operator In Charge Manufacturers		
Prior to Operation Inspectors Approval Obtained		
During Operation Qualified Operator In Charge Equipment Maintained Lubrication		

NOTES:

.1 This is a brief checklist and does not cover all procedures which may be advisable in a particular case.

.2 Prior to starting or operating each system complete the appropriate section of this form and submit it to the Departmental Representative.

.3 Submit completed copies of this form for each system with the certificate of substantial performance.

1.5 MF 170 Certificate of Testing and Balancing

I hereby declare that I _____

I am an employee/a principal of _____

And certify that the testing and balancing procedures specified under division 15 have been satisfactorily completed and I hereby certify that complete factual reports have been distributed.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be submitted when requesting inspection of substantial performance.

1.6 MF 171 Certificate of Duct Cleanliness

I hereby certify that I _____

I am an employee/a principal of _____

And have personally witnessed that the following duct systems have been vacuumed as necessary, are now clean and have been resealed with access panels in place at all cleaning openings in the ductwork.

FAN NO.	SYSTEM DESCRIPTION

SIGNED _____

DATE _____

NOTES:

.1 This certificate must be submitted when requesting inspection of substantial performance.

1.7 MF 172 Certificate of Fire Damper Inspection

I hereby certify that I _____

am an employee/a principal of _____

And that all fire dampers have been tested by removing the fusible link and witnessing closure of the damper.

SIGNED _____

DATE _____

- Contract drawings supplied by:_____
- Latest addendum number or date of plans used:_____

NOTES:

1. This certificate must be submitted when requesting inspection of substantial performance.

1.8 MF 173 Certificate of Penetrations Through Separations

I hereby certify that I _____

am an employee of _____

And have personally witnessed that all mechanical (HVAC & Plmb.) service penetrations through fire separations (rated & non-rated) and sound separations in the following areas have been properly sealed in accordance with the specified requirements.

AREA	**SIGNED**	**DATE**
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		

NOTES:

.1 This certificate must be submitted to the Departmental Representative when requesting an inspection.

1.9 MF 174 Certificate of Seismic Restraint Installation

I hereby declare that I _____ am an employee/a principal of _____

And certify that the seismic restraint of all mechanical equipment, piping and ductwork specified under Division 15 has been satisfactorily completed and that the installation meets the requirements of the B.C. Building Code as it relates to seismic restraint.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be submitted when requesting inspection of substantial performance.

1.10 MF 175 Certificate of Vibration Isolation

I hereby declare that I _____ am an employee/a principal of _____

And certify that the vibration isolation installation specified under Division-15 has been satisfactorily completed.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be submitted when requesting inspection of substantial performance.

1.11 MF 180 Checklist & Record – Items to be Handed to Departmental Representative

ITEM	RECEIVED	DATE
Chemical Test Kit		
Control Drawings (Framed/Plasticized)		
Fan Belts – Spare Sets		
Filters - Spare Sets (Panel and Final)		
Hydrometer & Specific Gravity Chart		
Identification Schedule (Framed)		
Maintenance Program (Schedules & Cards)		
Master Key For B.A.S. Field Panels		
Rated Access Door Keys		
Spare Chemicals		
Sprinkler Heads & Cabinet		
Test Thermometer		
Thermostat Keys		
Valve List (Framed)		
Water Cooler Spare Filters		
Differential Pressure Meter for Circuit Setting Balance Valves (15715)		
P/T Plug Master Test Kit (15715)		

NOTES:

.1 Copies of this form to be submitted to the Departmental Representative with all items signed off when requesting inspection of substantial performance.

1.12 MF 181 Checklist – Demonstration of Air Handling Systems

System: _____

	CONTRACTOR		DEPARTMENTAL REPRESENTATIVE	
ITEM	**SIGNED**	**DATE**	**SIGNED**	**DATE**
Review of System Concept				
Review of Maintenance Manual				
Review of System Balance				
Troubleshooting				
Points of required Maintenance				
Access to Equipment				
Location of Control Devices				
All Electric Interlocks				
All Alarms				
Temperature Control				
Air Pressure Control				
Air Volume Control				

NOTES:

.1 Contractor to submit copies of this form with each appropriate item signed and dated by the person having overall charge of commissioning when requesting inspection for substantial performance. (See MF 190).

.2 Departmental representative to sign off each item during the demonstration.

.3 Contractor to strike out items where they do not apply to the systems being demonstrated.

.4 Interlocks and controls to be demonstrated by following the descriptions and diagrams in the contract documents and proving that all controls function as required.

.5 Where multiple identical controls are installed (thermostats) the Departmental representative may elect to only witness sample items, but the person having charge of commissioning is expected to have checked all of them.

1.13 MF 182 Checklist – Demonstration of Water System

System: _____

	CONTRACTOR		DEPARTMENTAL REPRESENTATIVE	
ITEM	**SIGNED**	**DATE**	**SIGNED**	**DATE**
Review of System Concept				
Review of Maintenance Manual				
Review of System Balance				
Review of Chemical Treatment				
Troubleshooting				
Points of required Maintenance				
Access to Equipment				
Location of Control Devices				
All Electric Interlocks				
All Alarms				
Temperature Control				
Pressure Control				
Volume Control				

NOTES:

.1 Contractor to submit copies of this form with each appropriate item signed and dated by the person having overall charge of commissioning when requesting inspection for substantial performance. (See MF 190).

.2 Departmental representative to sign off each item during the demonstration.

.3 Contractor to strike out items where they do not apply to the systems being demonstrated.

.4 Interlocks and controls to be demonstrated by following the descriptions and diagrams in the contract documents and proving that all controls function as required.

.5 Where multiple identical controls are installed (thermostats) the Departmental Representative may elect to only witness sample items, but the person having charge of commissioning is expected to have checked all of them.

1.14 MF 183 Checklist – Demonstration of Refrigeration System

System: _____

	CONTRACTOR		DEPARTMENTAL REPRESENTATIVE	
ITEM	**SIGNED**	**DATE**	**SIGNED**	**DATE**
Review of System Concept				
Review of Maintenance Manual				
Review of System Balance				
Troubleshooting				
Points of required Maintenance				
Access to Equipment				
Location of Control Devices				
All Electric Interlocks				
All Alarms				
Temperature Control				
Pressure Control				

NOTES:

.1 Contractor to submit copies of this form with each appropriate item signed and dated by the person having overall charge of commissioning when requesting inspection for substantial performance. (See MF 190).

.2 Departmental Representative to sign off each item during the demonstration.

.3 Contractor to strike out items where they do not apply to the systems being demonstrated.

.4 Interlocks and controls to be demonstrated by following the descriptions and diagrams in the contract documents and proving that all controls function as required.

.5 Where multiple identical controls are installed (thermostats) the Departmental Representative may elect to only witness sample items, but the person having charge of commissioning is expected to have checked all of them.

1.15 MF 188 Checklist – Substantial Completion Submissions - HVAC

SECTION	ITEM	CHECKED
15010	Boiler Inspection Certificate	
15010	Gas Inspection Certificate	
15010	Equipment Extended Warranties Certificates	
15010	Equipment Inventory Sheets	
15010	Millwright Setting and Alignment Certificate	
15010	Lubrication of Equipment Checklist	
15010	Penetrations through Separations Certificate (MF-173)	
15015	Air and Liquid Balancing Report	
15015	Testing & Balancing Certificate (MF 170)	
15015	Fire Damper Inspection Certificate (MF 172) and Checked	
15015	Commissioning Report and Checklists	
15015	Operating & Maintenance Manuals	
15015	Record Drawings	
15015	Maintenance Program	
15015	Demonstration to Operating Staff agenda	
15190	Identification Schedules	
15241	Vibration Isolation Installation Certificate. (MF-175)	
15242	Seismic Restraint Installation Certificate. (MF-174)	
15602	Chemical Treatment and Cleaning Report for Piping Systems	
15620	Boiler Start-up Test Reports	
15651	Refrigeration System Start-up Test Reports	
15810	Duct Leakage Test Reports	
15810	Duct Cleanliness Certificate (MF 171)	
15955	Demonstrations Checklists (MF 181, 182, 183)	
15955	Items handed to Departmental Representative Checklist (MF 180)	
15955	Substantial Performance Certificate (MF(190)	
15955	Checklist of work remaining after Substantial (MF 191).	

NOTES:

.1 This list is provided as a checklist and may not include all substantial completion requirements.

1.16 MF 189 Checklist – Substantial Completion Submissions- Plumbing

SECTION	ITEM	CHECKED
	Operating & Maintenance Manuals.	
	Record Drawings.	
	Plumbing Inspection certificate	
	Buried drainage piping. Pipe leakage and bedding tests	
	Buried gas pipe covering report.	
	Water mains chlorination report.	
	Backflow prevention station test certificate	
	Hose Bibb operating keys. Signed receipt from Departmental Representative.	
	Pipe test reports	
	Spare Water filters.	
	Backflow prevention (RPPD) test certificate	

NOTES:

.1 This list is provided as a checklist and may not include all substantial completion requirements.

1.17 MF 190 Certificate of Substantial Performance Division 15

I hereby certify that I _____ am an employee / a principal / an agent

of _____

and have personally witnessed the following with regard to the mechanical systems work specified on the above project and that to the best of my knowledge except as noted on MF 191 (attached);

- The installation is complete and as specified.
- The systems have been commissioned and operate satisfactorily.
- Every control sequence and every control performs as specified.
- The systems are clean.
- All of the required submissions have been made to the Departmental Representative.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be completed submitted to the Departmental Representative when requesting inspection for substantial performance.

.2 If it is apparent during this inspection that the systems or their operation are seriously deficient then all reasonable costs of any subsequent inspections shall be deducted from the contract sum.

1.18 MF 191 Checklist – Work Remaining After Substantial Performance

		COMPLETION		
ITEM NO.	**DESCRIPTION**	**CLAIMED BY**	**DATE**	**VERIFIED DATE**

NOTES:

.1 This form must be filled in and submitted to the Departmental Representative when requesting inspection for substantial performance.

.2 Items arising out of this inspection will be added to the list by the Departmental Representative. Copies of the complete list will be circulated to the Departmental Representative, the Architect and the Contractor.

.3 The Contractor may include estimated values against the outstanding work but determination of the actual amounts to be held will be made by the Departmental Representative.

.4 The Contractor shall sign off each item as it is completed and submit the list monthly to the Departmental Representative. When all items are signed off the completed list shall be submitted with the certificate of total performance MF 192.

1.19 MF 192 Certificate of Total Performance – Division 15

I hereby certify that I _____ am an employee / a principal / an agent

of _____

and have personally witnessed that each item of outstanding work on the checklist and record of work remaining after substantial completion MF 191 (attached) has been satisfactorily completed and I hereby certify that the Mechanical systems work specified on the above project is complete.

SIGNED_____DATE _____

NOTES:

.1 This certificate must be completed and submitted to the Departmental Representative when requesting inspection for total performance.

.2 If it is apparent during this inspection that the systems or their operation are seriously deficient then all reasonable costs of any subsequent inspections shall be deducted from the contract sum.

END OF SECTION

Part 1 General

1.1 Related Work

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

1.2 General

.1 Provide external thermal insulation for plenums and ductwork as called for. Note: items listed that do not require insulation.

.2 Provide internal acoustical insulation for plenums and ductwork, as called for. Note: do not externally insulate any ductwork that is specified to be internally insulated.

.3 Journeyman insulation applicators, skilled in this trade, shall perform the work.

.4 Be responsible for ensuring that sufficient space is always provided to allow proper installation of insulation materials.

.5 As applicable, use the latest edition of the "B.C. Insulation Contractors Association (BCICA) Standards Manual" as a reference standard if sufficient detail/information is not specified herein.

1.3 Regulatory Requirements

.1 Flame spread ratings and smoke developed classifications shall be as required by the National Building Code of Canada 2005 and NFPA 90A. Generally the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50.

.2 Insulation thickness and insulating values shall be in accordance with ASHRAE 90.1.

1.4 Qualifications and Samples

.1 Submit, for approval, substantiating manufacturer's documentation (and samples when requested) for all materials, applications and finishing methods to establish that all will satisfy this specification and meet all applicable code requirements, before commencing work.

1.5 Definitions

.1 "CONCEALED" insulated mechanical services in furred spaces, shafts and hung ceilings considered to be concealed.

.2 "EXPOSED" will mean not concealed.

Part 2 Products

2.1 External Flexible Insulation

.1 External flexible glass fibre insulation with integral vapour barrier.

.1 Minimum density - 12 kg/cu.m. [3/4 lbs/cu. ft.].

.2 Thermal Conductivity at 24 deg.C. - 0.042 W/m/deg.C.

.3 Acceptable Manufacturers:

.1 Certainteed STD Ductwrap #75 FSK, Manson Alley-Wrap FSK, Owens Corning all service faced duct wrap, Knauf FSK Ductwrap, Schuller Micro Lite FSK, or equivalent.

2.2 Duct Liner

.1 Rigid Duct Liner

.1 Yellow or light coloured internal rigid glass fibre acoustical insulation with black sealer coating on one face.

.2 Minimum sound absorption (NRC) of 0.60 as tested per ASTM C423 using type "A" mounting.

.3 Thermal Conductivity at 24 deg.C. - 0.035 W/m/deg.C.

.4 Acceptable Manufacturers:

.1 Certainteed Toughgard 300#, Manson Akousti-Liner R, Knauf Rigid Coated Duct, Schuller Permacoat R300, Owens Corning Rigid Coated Duct Liner, or equivalent.

.2 Flexible Duct Liner

.1 Yellow or light coloured internal flexible glass fibre acoustical insulation with one face faced with non-woven fiberglass mat.

.2 Minimum sound absorption (NRC) of 0.60 as tested per ASTM C423 using type "A" mounting.

.3 Thermal Conductivity at 24 deg.C. - 0.040 W/m/deg.C.

.4 Acceptable Manufacturers:

.1 Certainteed Toughgard Duct Liner 50#, Manson Akousti-Liner, Knauf Duct LinerEM, Owens Corning Areomat Duct Liner, or equivalent.

2.3 Accessories

.1 Insulation Adhesive

.1 Bakelite 230-39, Childers CP-82, CP-56W, Epolux Cadoprene 400, Foster 85-20, Polymer Glasstack #25, Robson Ticki-Tuff, or equivalent.

.2 Vapour Barrier Tape

.1 Finishing tape as commercially available to meet flame spread rating and smoke developed classification requirements of NBC 1985 and compatible with facing material.

.2 Scrim foil self-adhesive tape.

.3 Vapour Barrier Adhesive

.1 Bakelite 230-21, Childers CP-82, Epolux Cadoprene 400, Foster 85-20, 3M 4230, or equivalent.

.4 Insulation Coating

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36, Robson White Lag, or equivalent.

.5 Weather Coating - vapour barrier

.1 Bakelite 110-14, Childers CHIL-PRUF CP22/23/24, Foster 60-25, Insul-Mastic 15187, or equivalent.

.6 Reinforcing Membrane

.1 Glass reinforcing membrane as commercially available.

.7 Seal Coating

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36, Robson White Lag, or equivalent.

.8 Fabric Adhesive

.1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36, or equivalent.

.9 Fabric Coating

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36, or equivalent.

2.4 Scope of Insulation

.1 Scope 1: External Flexible Insulation with vapour barrier. (Exposed ducts within a room, which is being served by the exposed ducts, do not require external insulation)".

	Thickness	
Service	**mm**	**[ins]**
All cooling and heating supply ducts; - where the temperature difference between the space within which the duct is located and the design air temperature in the duct, is less than or equal to 22.2°C [40°F]	40	[1.5]
All cooling and heating supply ducts; - where the temperature difference between the space within which the duct is located and the design air temperature in the duct, is greater than 22.2°C [40°F].	50	[2]
Outdoor air ductwork (from intake to mixing plenum).	50	[2]
Combustion air intake	50	[2]

	Thickness	
Service	**mm**	**[ins]**
Exhaust air discharge through roof (including sides and bottom of plenum).	50	[2]
Exhaust air ductwork outside the building.	25	[1]
All exhaust air ductwork from outside wall or roof to 1.5 m [5 ft.] inside building.	25	[1]

.2 Scope 2: Internal Flexible Duct Liner

	Thickness	
Service	**mm**	**[ins]**
All ductwork where indicated by single hatching	as indicated on drawings	
All hot and cold supply ductwork in the mechanical room (from A.H.U. discharge to duct shaft)	50	[2]

Part 3 Execution

3.1 Application

.1 Apply external insulation to ductwork only after all tests have been made and systems accepted by the Departmental Representative as air tight.

.2 Apply insulation and insulation finish in a workmanlike manner so that the finished product is uniform, smooth in finish, pleasing to the eye and with longitudinal seams concealed from view. Apply ductwork insulation materials, accessories and finishes in accordance with manufacturer's recommendations.

.3 Insulation and vapour barrier shall be continuous through all non-rated separations.

3.2 Insulation Termination

.1 Terminate insulation short of all control, smoke and fire dampers so as not to interfere with their operation.

3.3 External Flexible Insulation with Vapour Barrier

.1 Adhere insulation with insulation adhesive applied in 150 mm [6"] wide strips on 300 mm [12"] centres.

.2 On rectangular ductwork and plenums, over 610mm [24"] in width, spotweld pins 6mm [1/4"] longer than the insulation thickness, one per square foot of duct minimum. If pins are installed in the field, a capacitor gun shall be used. Impale the insulation over the pins, and hold in place

using metal or nylon clips (washers). Alternatively, use an assembly consisting of a welded pin with integral head washer welded in place over the insulation. (Clinched pins not acceptable).

.3 Adhere foil faced vapour barrier tape over all butt joints, raw edges, holding washers and other points of penetration of the vapour barrier jacket on all exposed hot and cold ducts and concealed cold ducts.

3.4 Internal Flexible Duct Liner Application

.1 Adhere insulation with insulation adhesive applied to the whole of the metal surface, with the coating side of insulation exposed to the airstream.

.2 Ducts 610 mm [24"] in width and less require no further adhesion.

.3 Ducts sides and plenum panels greater than 610 mm [24"] in width shall also have metal clips or nylon pins adhered to the metal surface at 300 mm [12"] to supplement the adhesive. (Welding pins may be used provided a capacitor type gun is used.) Impale insulation or the pins or clips, with the coated side of the insulation exposed to the airstream and secured with holding washers. Cover holding washers with reinforcing membrane and insulation coating / sealer.

.4 Seal all transverse joints, raw edges, and other points of penetration of the coating with reinforcing membrane and insulation coating/sealer.

.5 Seal all longitudinal joints with insulation coating sealer.

.6 .6 No raw edges of internal insulation material shall be exposed to the moving airstream.

.7 NOTE: duct size shown is dimension inside the insulation. Metal duct sizes shall be increased to allow for the internal acoustic insulation thickness.

3.5 Ductwork Insulation Finishes

.1 "Concealed" ductwork insulation, in horizontal and vertical service spaces, will require no further finish.

.2 "Exposed" ductwork insulation "inside" finished floor spaces, fan rooms, boiler room, valve rooms shall be finished with two coats of white, foil-finishing, insulation coating.

.3 "Exposed" ductwork insulation "outside" the building shall have a weatherproof finish. Apply one coat of Childers Vi-cryl CP10, or other approved, asphaltic emulsion mastic, at the rate of 1 litre per square metre. Immediately embed #10 glass fabric into the wet coating. Smooth out all wrinkles, lapping ends and edges at least 50 mm [2"]. After the first coating has achieved initial set, but while still damp, apply a top finish coating of the asphalt emulsion mastic at 2 litres per square metre ensuring that the reinforcing glass fabric is completely coated. Smooth to a uniformly even finish.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 GENERAL

.1 Provide thermal insulation for all heating and cooling equipment as called for and scheduled.

.2 Journeyman insulation applicators, skilled in this trade shall perform the work.

.3 Be responsible for ensuring that sufficient space is provided to allow proper installation of insulation materials.

.4 As applicable, use the latest edition of the "B.C. Insulation Contractors Association (BCICA) Standards Manual", as a reference standard, if sufficient detail/information is not specified herein.

1.3 REGULATORY REQUIREMENTS

.1 Flame spread ratings and smoke developed classifications shall be as required by the National Building Code of Canada 2005 and NFPA 90A. Generally, the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50. Materials shall not flame, smolder, glow, or smoke at the temperature to which they are exposed in service.

.2 Insulation thickness and insulating values shall be in accordance with ASHRAE90.1.

1.4 QUALIFICATIONS AND SAMPLES

.1 Submit, for approval, substantiating manufacturers documentation (and samples when requested) for all materials, applications and finishing methods to establish that all will satisfy this specification and meet all applicable code requirements, before commencing work.

1.5 DEFINITIONS

.1 "EXPOSED". All equipment shall be considered to be exposed in boiler room, chiller room, valve room and fan rooms.

Part 2 Products

2.1 PREFORMED BLOCK AND BOARD INSULATION

.1 Mineral Fibre (High Temperature) Rigid

.1 Thermal Conductivity at 93oC - 0.046 W/m/deg.C.

.2 Acceptable Manufacturers:

.1 Fibrex FBX1900, Owens-Corning Rocboard 1280, Rocblok PK-16, Roxul RHF, or equivalent.

.2 Phenolic Insulation Rigid Board

.1 With integral FRK jacket for ducts.

.2 Thermal conductivity at 24°C – 0.019 W/m/deg.C.

.3 Flame spread and smoke density does not exceed 25/50 per ASTM E84 with or without integral jacket.

2.2 FLEXIBLE SHEET INSULATION

.1 Flexible Closed Cell

.1 Thermal Conductivity at 24oC - 0.036 W/m/deg.C.

.2 Acceptable Manufacturer:

.1 Bonotex Polyethylene, Therma-Cel, or equivalent.

.2 Flexible Foamed Elastomeric

.1 Thermal Conductivity at 24°C - 0.039 W/m/deg.C.

.2 Acceptable Manufacturers:

.1 F/R Armaflex II, Rubatex R-180FS, or equivalent.

2.3 REMOVABLE INSULATION COVERS

.1 Flexible mineral fibre or fibre glass fully enclosed on all sides and edges within Alpha Maritex #8459-2-8S silicone fibre glass cloth suitable for temperatures involved with stainless steel wire mesh against hot surface.

.2 Insulation covers to be laced in place with brass/stainless steel hooks and copper/stainless steel wire and be easily removable.

2.4 ACCESSORIES

.1 Jacket Fastenings (Multi-Purpose)

.1 Staples (flare type). Stainless steel.

.2 Compatible jacket finishing tape.

.2 Corner Beads

.1 38 mm x 38 mm x 0.37 mm thick galvanized steel or aluminum as commercially available.

.3 Finish Jacket

.1 Thermocanvas Jacket

.1 Fattal's Thermocanvas, Robson Flamex FR Canvas, Tai-Can Canvas, or equivalent.

.2 Metal Jacket

.1 Childers 0.53 mm [22 ga], Alcan Thermoclad I, or other as commercially available.

.4 Reinforcing Membrane

.1 Glass reinforcing membrane, as commercially available.

.5 Reinforcing Mesh

.1 25.4 mm square galvanized wire mesh, as commercial available .

.6 Insulating Cement

.1 Ryder Thermokote MW High Temp, Partek No. 1, or equivalent.

.7 Hard Finish Cement

.1 As commercially available.

.8 Fabric Adhesive

.1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 8142W, Robson White Lag, or equivalent.

.9 Fabric Coating

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36, or equivalent.

2.5 EQUIPMENT INSULATION SCOPE AND THICKNESS TABLE

Equipment	Thickness - mm [ins]		Scope
Boiler stack(s)	50	50 [2]	A
Domestic hot water tank(s)	50	[2]	A
Domestic cold water meter(s)	20 [3/4] 13 (1/2)		B, D
Expansion joints	50	[2]	C
Heat Exchanger(s) (shell, end & head)	50	[2]	A
Heating loop buffer tank (condenser)	50	[2]	A
Chiller pump loop buffer tank (chilled water)	50 [2]	B, D	

SCOPE A: Preformed block insulation (high temperature)

SCOPE B: Flexible sheet insulation SCOPE C: Removable insulation cover SCOPE D: Preformed board insulation

Part 3 Execution

3.1 APPLICATION

.1 Apply insulation to equipment only after all connections to it are completed and all tests have been made and systems accepted as tight.

.2 Apply insulation and insulation finish, in a workmanlike manner carefully securing it permanently to all surfaces of the equipment. Finish the work so that the finished product is pleasing to the eye, uniform in application and smooth in finish with all edges protected and sealed.

.3 When more than one layer of insulating material is used to achieve the specified thickness, stagger the seams and joints to eliminate leakage paths.

.4 Weld insulation attachment fittings to surfaces, as required, to completely secure block insulation with mechanical, wire or strap fastenings.

3.2 NAMEPLATES

.1 Install insulation so that name and registration plates, clean-outs, manholes, inspection openings and gauge and controller tappings remain uncovered. Cut back insulation around the base of these items at 45 degrees and finish with finishing cement.

3.3 INSULATION - HOT APPLICATIONS

.1 Apply high temperature insulation block and/or preformed/molded pipe insulation and secure firmly to all surfaces with mechanical, wire or strap fastenings. Insulation shall be cut as required, shaped and fitted neatly to all contours, without voids.

.2 The insulation on equipment heads shall receive a 12 mm [1/2"] trowel coat, dry thickness of insulating hard coat finishing cement, to provide a smoothly contoured surface. The cement shall be reinforced with a layer of reinforcing mesh or a reinforcing membrane.

.3 Apply high temperature mineral fibre rigid insulation to the boiler breeching. Exterior application shall be sealed from moisture. Over the insulation, apply 0.53 mm [22 ga] thick aluminum. The longitudinal seams shall be located to shed water. Attach with holding strap at 150 mm [6"] on centres. Provide a complete aluminum jacket system using all of the parts, accessories and installation procedures of the manufacturer. Seal all outdoor jacketing watertight. Overlap all seams by a minimum of 75 mm [3”]. Expansion springs on bands may be required.

3.4 INSULATION - COLD APPLICATIONS

.1 Apply flexible sheet insulation on all cold surfaces. Secure material and longitudinal and butt joints with foam plastic adhesive. Insulation shall be cut as required and be shaped and fitted neatly to all contours, without voids.

.2 Secure board insulation on ducts and flat surfaces with adhesive and pins. Seal the vapour barrier finish joints with self-adhesive foil tape.

3.5 BLOCK INSULATION FINISH

.1 Premium Finish: Over hard finish cement apply thermocanvas jacket using fabric adhesive. Finish fabric jacket with one coat of fabric coating.

3.6 FLEXIBLE SHEET FINISH

.1 Insulated flexible sheet insulation shall be painted with a heavy brush coating of foam plastic, white insulation coating.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 GENERAL

.1 Provide thermal insulation on all piping, valves and fittings, as called for and as scheduled. Note items listed that do not require insulation.

.2 Journeyman insulation applicators, skilled in this trade, shall perform the work.

.3 Be responsible for ensuring that sufficient space is always provided to allow proper installation of insulation materials.

.4 As applicable, use the latest edition of the "B.C. Insulation Contractors Association (BCICA) Quality Standards Manual", as a reference standard if sufficient detail/information is not contained herein.

1.3 REGULATORY REQUIREMENTS

.1 by the National Building Code of Canada 2005 and NFPA 90A. Generally, the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50.

.2 Insulation thickness and insulating values shall be in accordance with ASHRAE90.1.

1.4 QUALIFICATIONS AND SAMPLES

.1 Submit, for approval, substantiating manufacturer's documentation (and samples when requested) for all materials, applications and finishing methods to establish that all will satisfy this specification and meet all applicable code requirements, before commencing work.

.2 Submit, for approval, samples of each type of firestopping, smoke seal and accessory.

1.5 DEFINITIONS

.1 "CONCEALED" insulated mechanical services in trenches, chases, furred spaces, shafts and hung ceilings (services in tunnels are not considered to be concealed.)

.2 "EXPOSED" will mean not concealed.

1.6 CONNECTIONS TO EXISTING PIPING (WHERE APPLICABLE)

.1 Make good all existing insulation disturbed or removed to facilitate alterations and additions to existing piping.

Part 2 Products

2.1 PREFORMED PIPE COVERING

.1 Mineral Fibre - Low and Medium Temperature:

.1 With integral vapour barrier jacket and longitudinal lap.

.2 Thermal conductivity at 24oC - 0.033 W/m/deg.C.

.3 Acceptable Products:

.1 Manson Alley K, Owens Corning SSL-11, Knauf 850 ASJ/SSL, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL, or equivalent.

.2 Mineral Fibre - High Temperature:

.1 With integral vapour barrier jacket and longitudinal lap.

.2 Thermal Conductivity at 93°C - 0.040 W/m/deg.C.

.3 Acceptable Products:

.1 Manson Alley Kapt, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL, Roxul ASJ/SL, or equivalent.

.3 Flexible Foamed Elastomeric:

.1 Thermal Conductivity at 24°C - 0.040 W/m/deg.C.

.2 Acceptable Products:

.1 AP Armaflex, Rubatex R-180-FS, or equivalent.

.4 Flexible Closed Cell:

.1 Thermal Conductivity at 24°C - 0.036 W/m/deg.C.

.2 Acceptable Products:

.1 Bondtex Polyethylene, Therma-Cel, or equivalent.

.5 Phenolic closed cell – rigid:

.1 With integral vapour barrier jacket and longitudinal lap.

.2 Thermal conductivity @ 24oC - 0.019 W/m/deg.C.

.3 Acceptable Products:

.1 Kingspan Koolphenk, or equivalent

2.2 FIRE STOPPING AND SMOKE SEAL MATERIALS

.1 References:

.1 CAN4-S115-[M95], Standard Method of Fire Tests of Firestop Systems.

.2 ASTM E814 Standard Method of Fire Tests and Through-Penetration Firestops.

.3 1997 Certifications Listings Intertek Testing Services N.A. Ltd. (Warnock Hersey).

.4 Underwriters Laboratories of Canada. Listing of Equipment and Materials Vol. 3 Fire Resistance Ratings -Revision 4/95.

.2 Submittals:

.1 Submit shop drawings and product data (including MSDS sheets for VOC content).

.2 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.

.3 Submit manufacturers' product data for materials and prefabricated devices. Include assembly/location design system number references with copies of test information.

.4 For building assemblies which do not correspond to any previously tested and rated assemblies, submit proposals based on related designs using accepted fireproofing design criteria.

.3 Materials:

.1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC CAN4- S115 and not to exceed opening sizes for which they are intended.

.2 Service penetration assemblies and design numbers: Certified by ULC in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19. 1997 Certification Listings Intertek Testing Services N.A. Ltd. (Warnock Hersey).

.3 Service penetration firestop components: Certified by ULC in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC or equivalent approved tests by Warnock Hersey.

.4 Fire resistance rating of installed fire stopping assembly shall be not less than the fire resistance rating of surrounding floor and wall assembly.

.5 Acceptable Products:

.1 3M 1000 silicone, Tremco Fyre-Sil, 3M CP25WB, Firestop Systems 4800DW, Nuco Self Seal Fire Stops, or equivalent.

2.3 ACCESSORIES

.1 Insulation Fastenings:

.1 1.6 mm [16 ga.] galvanized wire or 1.6 mm thick copper wire as commercially available.

.2 Jacket Fastenings:

.1 Thermocanvas and All Service:

.1 Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacturer.

.2 Metal Jackets:

.1 Sheet metal screws, pop rivets, bands.

.3 PVC Jacket and Fitting Covers:

.1 PVC self-adhesive tape, plastic pop rivets, bonding cement.

.3 Adhesives:

.1 Flexible elastomeric and flexible closed cell insulation adhesive:

.1 Armstrong 520, Therma-Cel 1590, RubatexR-373, Zipcoat 8A, or equivalent.

.2 Vapour barrier jacket adhesive:

.1 Bakelite 230-39, Childers CP-82, Epolux Cadoprene 400, Foster 85-20, or equivalent.

.3 Fabric adhesive, to insulation pipe covering:

.1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36, Robson White Lag, or equivalent.

.4 Coatings:

.1 Vapour barrier coating on reinforcing membrane or on insulating cement:

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36, or equivalent.

.2 Childers CP-30 (refrigeration suction lines only).

.2 Flexible elastomeric and flexible closed cell insulation finish coating:

.1 Armstrong, Bakelite 120-13, Rubatex, Zipcoat, or equivalent.

.5 Finish Jackets:

.1 Thermocanvas Jacket:

.1 Fattal's Thermocanvas, Robson Flamex FR Canvas or Tai-Can Canvas, or equivalent.

.2 All Service Jacket (with 0.03 mm [0.0019”] minimum thick foil:

.1 Fattal's Fat-Lock ASJ, Fiberglass ASJ, Knauf ASJ, Kingspan ASJ, Manson APT, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ, or equivalent.

.3 PVC Finishing Jacket (minimum 0.50 mm [0.02”] thick:

.1 Proto PVC, Speedline PVC, Zeston PVC, or equivalent.

.4 Aluminum Jacket:

.1 0.51 mm [22 ga.] thick corrugated or smooth aluminum jacketing with longitudinal slip joints and 50 mm [2"] end laps with factory applied protective liner on interior surface.

.1 Childers, Alco Thermoclad 1 or other as commercially available, or equivalent.

.5 Reinforcing Membrane:

.1 Glass reinforcing membrane as commercially available.

.6 Insulating Cement:

.1 Fibrex Superkote, Partek No. 1, Ryder Thermokote MW high temperature, or equivalent.

.7 Finishing Cement:

.1 Ryder Thermokote 1 FW, or equivalent.

.8 Flexible Insulation:

.1 Manson Alley-Wrap, Owens Corning AF 300 Series, Knauf Plain Wrap, Johns Manville Microlite, Roxul Wrap (RW) , or equivalent.

.9 Preformed Fitting Covers:

.1 Aluminum Fitting Covers:

.1 0.51 mm [22 ga.] thick, die shaped components with factory applied protective liner on interior surface.

.1 Childers Ell-Jacs, Perma-Ells or Shield-Ells or other as commercially available, or equivalent.

.2 PVC Fitting Covers:

.1 0.50 mm [0.020"] thick pre-moulded one piece covers.

.1 Certainteed Snapform, Childers, Proto PVC, Speedline PVC, Zeston PVC, Fattal PVC, or equivalent.

.10 Preformed Insulation fittings:

.1 Shur-Fit, Moulded Acoustic Products or from insulation fabricators, or equivalent.

2.4 SCOPE OF INSULATION

.1 Heating Pipe, Fittings and Valves:

.1 Insulate the following systems, unless otherwise noted:

.1 Hot water heating supply and return piping.

.2 Flexible branch connections to ceiling radiant heat panels.

.3 Hot gas piping.

.4 Any other hot water piping.

.2 DO NOT insulate the following, unless otherwise noted:

.1 Relief piping.

.2 Drain lines.

.3 Small branch risers to terminal heating elements just above floor level, from 150 mm [6"] below floor slab up to heating element.

.4 Flexible interconnections between ceiling radiant heating panels.

.3 Insulate the following valves and fittings if the pipe is insulated:

.1 Elbows, tees, reducers.

.2 Valve bodies on valves and check valves, over NPS 2-1/2".

.3 Flanges.

.4 Strainers.

.4 The following hot pipe fittings that operate at 49o C [120o F] shall be coated with Thermalite –SG as per manufacturer's specifications to prevent skin burns:

.1 Valves, NPS 2-1/2" and smaller.

.2 Valve bonnets.

.3 Unions.

.4 Flexible connections.

.5 Expansion joints.

.6 Check valve covers.

.2 Chilled water and refrigerant piping, fittings and valves:

.1 Insulate and vapour seal the following systems, unless otherwise noted:

.1 Chilled water supply and return piping.

.2 Refrigerant suction piping for comfort cooling.

.3 Refrigerant suction piping for product refrigeration.

.2 DO NOT insulate the following, unless otherwise noted:

.1 Drain lines for sumps 15oC [60oF] and over.

.3 Insulate and vapour seal the following fittings, if the pipe is insulated:

.1 Elbows, tees, reducers.

.2 Valves, (bodies and bonnets) except check valve covers.

.3 Strainers.

.4 Flanges.

.5 Unions.

.3 Plumbing pipes, fire suppression pipes, fittings, valves:

.1 Insulate the following systems, unless otherwise noted:

.1 Domestic cold water system including meter body and including traps on handicapped lavatories.

.2 Domestic hot water supply and recirculation piping.

.3 Domestic tempered water supply and recirculation piping.

.4 Underside of drain bodies, rainwater leaders, storm drainage piping and fittings for the entire system.

.5 All drains, lines, stacks,* fire standpipes and sprinkler mains in unheated areas (insulation shall cover heat tracing cables).

.6 Water valves, flanges, PRV's, strainers, check valves.

.7 Sprinkler / standpipe system from domestic water connection point to 5 metres [16 ft] downstream thereof or to the inlet of the alarm valve, whichever is less.

.8 Interior irrigation / hose bibb supply piping.

.2 DO NOT insulate the following, unless otherwise noted:

.1 Piping used exclusively for fire protection (unless in unheated spaces).

.2 Soil stacks, vents, etc.,

.3 All special service piping, e.g. gas, compressed air, etc.

.4 Unions.

.5 Flexible connections or expansion joints (unless noted on the drawings).

.6 Check valve covers.

.7 Strainer leg and basket covers.

.8 Flexible fixture connections.

.4 Pipe penetrations through walls and floors:

.1 All material for the stuffing, sealing and caulking of the pipe penetration shall be supplied and installed under this section.

2.5 PIPE INSULATION THICKNESS TABLE - MM [INS]

			NOMINAL PIPE SIZE (NPS)			
Service	Design Operating Temperature	Runouts 2 and less(note 1)	1 and less	11/4 to 2	21/2 to 4	5 and larger
Continuous C.W. Drainage	5 oC [40 oF]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]
Domestic Cold Water	5oC [40oF]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]
Domestic Hot & Tempered Water Supply and Recirculation	40-70 oC [105-160oF]	25 [1]	25 [1]	40 [1.5]	40 [1.5]	40 [1.5]
Hot Water Heating	50-90oC [120-200oF]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]
Hot Water Heating	96-120oC [205-250oF]	40 [1.5]	40 [1.5]	50 [2]	50 [2]	90 [3.5]
Buried & Exterior Rainwater Storm Drainage	5oC [40oF]	none	none	none	none	none
Above Grade Interior Rainwater Storm Drainage	5oC [40oF]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]
Refrigerant suction and hot gas	5oC [40oF] or lower	25 [1]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]

			NOMINAL PIPE SIZE (NPS)			
Chilled water supply and return	10oC [50oF]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]
Heat pump heating loop (heat recovery for DHW						
& dry fluid cooler heat rejection loop)	49oC [120oF]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]
Condensate lines	6oC [45oF]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]

Part 3 Execution

3.1 APPLICATION

.1 Apply insulation to piping only after all tests have been made and systems accepted by Departmental Representative tight.

.2 Apply insulation and insulation finish in a workmanlike manner so that the finished product is uniform in diameter, smooth in finish, pleasing to the eye and with the longitudinal seams positioned to be concealed from view. Apply piping insulation materials, accessories and finishes in accordance with manufacturer's recommendations.

.3 On piping NPS 2-1/2 and larger with insulation and vapour barrier, install high density insulation above hanger shield. Insert to be slightly longer than the length of shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.

.4 Insulation and vapour barrier shall be continuous through all non-rated separations.

3.2 INSULATION TERMINATION POINTS

.1 Terminate insulation 75 mm [3"] back from all uninsulated fittings to provide working clearance and terminate insulation at 90o and finish with reinforced scrim cloth and vapour barrier mastic system. Cover onto pipe and over the insulation vapour barrier. On concealed hot services terminate insulation 75mm [3"] back from all uninsulated fittings, cut off at 90o and apply reinforced scrim cloth and breather mastic system.

.2 Cut back insulation at 45o and finish with a silicone caulking sealant around the base of thermometer wells, pressure gauges, flow switches and pressure and control sensors.

3.3 VERTICAL RISERS

.1 On vertical pipe over 75 mm [3"] provide insulation supports welded or bolted to pipe, directly above lowest pipe fitting. Thereafter, locate on 4.5 m [15 ft.] centres.

3.4 HOT APPLICATION 26.7°C [80°F] AND OVER

.1 Piping:

.1 Install medium temperature pipe insulation with integral jacket to pipe and hold in place by stapling the flap, with spreading staples at 75 mm [3"] centres. Pipe insulation with integral self-sealing jacket will not require additional fastening.

.2 Install strips of vapour barrier jacket over butt joints and secure with spreading staples.

.2 Fittings:

.1 Insulate fittings, to thickness of adjacent pipe insulation, with sections of the pipe insulation mitred to fit tightly, or with preformed insulation fittings (Shur-Fit, or equivalent) or from insulation fabricator.

.3 Valves, Strainers:

.1 Insulate valve bodies and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation or insulate with preformed insulation fittings (Shur-Fit, or equivalent) or from insulation fabricator. Drains, blowoff plugs and caps shall be left uncovered.

.4 Flanges and Victaulic Fittings:

.1 Do not insulate flanges on condenser/heat pump water piping inside the building.

.2 Insulate flanges on condenser/heat pump water piping outside the building.

.3 Insulate flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe insulation. Insulation to overlap adjoining insulation at least 75 mm [3"].

3.5 COLD APPLICATION 10°C [50°F] AND LESS

.1 Piping:

.1 Install low/medium temperature pipe insulation with integral vapour barrier jacket to pipe and hold in place by securing the jacket flap. Seal all flaps with vapour barrier adhesive. Pipe insulation with integral self-sealing vapour barrier jackets will not require additional fastening.

.2 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive. Over wrap butt strips by 50 percent for insulation O.D. 300 mm [12"] and above apply strips on 250 mm [10"] centres for additional securement.

.2 Fittings:

.1 Insulate fittings to thickness of adjacent pipe insulation with sections of the pipe insulation mitred to fit tightly, or preformed insulation fittings (Shur-Fit, or equivalent), then apply reinforcing membrane embedded barrier coating and apply finish vapour barrier coating.

.2 Alternatively insulate fittings with tightly placed flexible insulation and apply pre-moulded 25/50 rated PVC fitting covers. Apply vapour-barrier adhesive and tape on all joints and overlaps.

.3 Valves, Strainers:

.1 Insulate valve bodies, bonnets and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation, then apply reinforcing membrane embedded in barrier coating. Alternately, insulate with preformed insulation fittings (Shur-Fit, or equivalent) covered with reinforcing membrane, stapled in place and covered with a barrier coating. Drains, blow-off plugs and caps shall be left uncovered.

.4 Unions, Flange and Victaulic Fittings:

.1 Insulate cold unions and flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe covering, then apply reinforcing membrane embedded in barrier coating and final coating of vapour barrier mastic.

3.6 ANTI-SWEAT COATING

.1 Coat with an anti-sweat coating - "No Sweat" by Robson Thermal Mfg. Ltd., or equivalent, the following uninsulated cold surfaces:

.1 Connecting surfaces of thermometers, pressure gauges, flow switches, controllers, etc.

.2 The coating thickness shall be as recommended by the coating manufacturer for the system operation conditions.

3.7 PIPE INSULATION FINISHES

.1 "Concealed" insulation in horizontal and vertical service spaces will require no further finish.

.2 "Concealed" pipe insulation in damp locations, e.g. pipe trenches shall have a vapour barrier jacket, vapour sealed.

.3 "Exposed" flexible insulation shall be painted with a heavy brush coating of foam plastic white insulation coating.

.4 "Exposed" insulation inside the building shall be finished as follows:

.1 Premium Finish: Outside closed shafts:

.2 Over a factory applied integral all-service type jacket on the pipe insulation, apply PVC jacket.

.3 Over insulated fittings apply PVC fitting covers. Over insulated valve bodies, valve bonnets, strainers and flanges apply purchased PVC covers or field fabricate from PVC sheeting secured with solvent bonding cement.

.4 Finish fabric with one coat of fabric coating.

.5 Economy Finish: Inside closed shafts:

.1 Apply pipe insulation with an integral all-service type jacket. Cover longitudinal and circumferential joints with jacket finishing tape neatly applied. Alternately secure jacketing longitudinal joint using integral self- sealing lap. Cover circumferential joints with jacket finishing butt strips. Over wrap strips by 50 percent. For insulation O.D. 300 mm [12”] apply strips on 250 mm [10”] centres for additional securement. PVC, especially, 0.020” thick should not be used as a vapour barrier alone. Should have ‘ASJ’ or mastic system under it. Over insulation on short pipe runs and piping adjacent to fittings, valves, etc., jacket to be field applied.

.2 Over insulated fittings apply tack coat of vapour barrier mastic and embed reinforcing membrane and cover with same mastic. Over insulated valve bodies, valve bonnets, strainers and flanges, apply all-service jacketing using necessary fastenings and jacket finishing tape and with the reinforced mastic system on irregular surfaces.

.3 "Exposed" outdoor insulation [including in the parking garage] shall be finished as follows:

.1 Insulation shall have a vapour sealed vapour barrier jacket.

.2 Over the pipe insulation jacket apply aluminum weather protecting jacket. The longitudinal seam shall be located to shed water. Secure the jacket using necessary metal banding on approximately 250 mm (10”) centres and at the overlaps. Screws are not permitted on cold operating systems, since they will penetrate the vapour barrier.

.3 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply metal jacket or preformed metal fittings to provide a complete jacket system. Secure with necessary fastenings.

.4 Seal all outdoor jacketing watertight.

3.8 HIGH TEMPERATURE PIPING - OVER 200OC [400OF]

.1 Install high temperature preformed pipe insulation, 75 mm [3"] thick, on the emergency generator exhaust piping upstream from the [wall] [roof] thimble, including the silencer. Secure in place with galvanized steel bands or 1.6 mm [16 ga] galvanized wire at 300 mm [12"] on centres. DO NOT insulate flexible connection to manifold.

.2 Where concealed, or exposed insulate fittings with molded 2-piece covers or mitred pipe insulation to cover fittings to the thickness of adjoining insulation.

.3 Insulate all flanges and unions. Install sections of oversized preformed pipe insulation to overlap adjoining insulation at least 75 mm [3"].

.4 At insulation termination points, cut back insulation at 45o and finish with a hard coat of insulating cement to match the adjacent insulation.

.5 Finish:

.1 Apply vinyl foil laminate vapour barrier jacket ASJ.

.2 Where exposed inside the building cover the vapour barrier jacket with PVC jacket.

.3 Where exposed outside the building - apply a 0.41 mm [0.016"] thick aluminum weather protecting jacket with longitudinal seams located to shed water. Overlap all seams 50 mm (2”) and secure with metal banding 250 mm (10”) centres and at the overlaps.

3.9 REFRIGERATION SUCTION PIPING OUTSIDE BUILDING

.1 Install flexible foamed elastomeric or flexible closed cell preformed piping insulation. Secure longitudinal and butt joints with adhesive. Insulate all fittings and components. To obtain the specified thickness, apply in layers with staggered joints.

.2 Finish with flexible elastomeric or flexible closed cell insulation coating.

.3 Provide embossed aluminum jacket.

3.10 FIRE STOPPING AND SMOKE SEALS

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

.2 Maintain insulation around pipes penetrating fire separation only as permitted by Firestop Assembly Listing.

.3 Submit Certificate of Inspection (Form MF173) that all work is complete and in accordance with the specified requirements before Substantial Completion.

END OF SECTION

1 GENERAL

1.1 Related Sections

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

.2 Division 01 – General Requirements.

.3 Section 22 05 00 – Plumbing – General.

.4 Section 23 05 00 – General Requirements.

.5 Section 23 08 01 – Performance Verification.

.6 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

.7 Section 23 09 93 – Controls Sequence of Operation.

.8 Section 26 05 00 – Common Work Results for Electrical.

1.2 Quality Assurance

.1 CSA Standard Z320 -2011 Building Commissioning.

.2 ASHRAE Standard 202-2013 Commissioning Process for Buildings and Systems.

.3 ASHRAE Guideline 1.1-2007 HVAC&R Technical Requirements for the Commissioning Process.

1.3 General

.1 Be responsible for the performance and commissioning of all equipment supplied under the sections of Division 22 and 23. Commissioning is the process of advancing the installation from the stage of static completion to full working order in accordance with the contract documents and design intent. It is the activation of the completed installation.

.2 In consultation with the Commissioning Manager (Prime Contractor), ensure that sufficient time is allowed and fully identified on the construction schedule for the proper commissioning of all mechanical systems. Coordinate mechanical commissioning activities with the Cx Manager to avoid redundancies and inefficiencies. The mechanical commissioning agent shall report to the Cx Manager and assist the Cx Manager with mechanical commissioning activities as they directly relate to the Cx Manager activities noted in Division 01 sections.

.3 See Division 01 specifications for project commissioning definitions, acronyms, roles, and responsibilities. Division 01 requirements are to supersede any of the requirements listed below in case of requirements discrepancy.

.4 Commission each subsystem as mechanical systems are installed. At the completion of all subsystems, commission the entire system as a whole. Provide multiple commissioning reports (one per subsystem), and final summary commissioning report for the entire system.

1.4 Submittals

.1 In accordance with Section 01 33 00 Submittal Procedures.

.2 Submit commissioning plan, and commissioning reports.

1.5 Commissioning and Demonstration

.1 Provide the services of an approved independent specialist firm (commissioning agent) to coordinate the commissioning process specified under this division and those items of other Divisions which interact with work of this Division as outlined herein, including the complete life safety and fire protection system that are affected by this renovation.

.2 The cooperation of all trades and the project team is essential for an efficient and planned process. A team comprising the following is recommended:

.1 Departmental Representative

.2 Commissioning Authority

.3 Prime Contractor's Commissioning Manager

.4 Division 23 Mechanical Trades (including Controls)

.5 Division 26 Electrical Trades

.3 Prepare a commissioning statement for each of the four [4] phases that the process is perceived to be worked through. In sequence, the phases are expected to be:

.1 PHASE 1 - System readiness.

.2 PHASE 2 - System start-up, testing, balancing etc.

.3 PHASE 3 - Verification of system performance.

.4 PHASE 4 - Demonstration & instruction.

.4 Each phase is applicable to each major and/or separate system making up the work in Division 23 plus Division 26 interface as applicable.

.5 Regular meetings shall be held during the commissioning process. Minutes of the meetings shall be issued to all contractors involved, the Commissioning Authority, and the Departmental Representative. Meeting times shall be coordinated with the Cx Manager.

.6 Plan the work to be specific in respect of personnel, schedule, review and factory tests.

.1 Personnel: Assign direct overall charge of commissioning to a person (the commissioning agent) fully qualified through practical experience and a comprehensive knowledge of the interactive nature of building systems and their controls to understand the

complete system and be available to carry the project through to total completion. This person shall be responsible for: Commissioning, Demonstration to the Commissioning Authority and Departmental Representative and issuing certificates of Substantial and Total Performance.

.2 Schedule: Submit a schedule, as part of the construction schedules, for the commissioning phase of the work. This schedule shall show:

.1 Equipment start-up schedule.

.2 Submission dates for the various documents required prior to substantial performance.

.3 Timing of the various phases of the commissioning, testing, balancing, and demonstration process.

.3 Review: Within [2] weeks of commencing with the project work, the person having direct overall charge of mechanical Cx shall review design intent and intended commissioning procedures with the Cx Manager, Cx Authority and Departmental Representative. Six [6] weeks prior to the date of scheduled substantial performance, submit a detailed plan that addresses the entire approach to the commissioning process. The plan should be prepared specifically for the project at hand. The plan should include the following components:

.1 Name and qualifications of the commissioning agent.

.2 Itemized check lists for the readiness, start-up and operational verification of all equipment and systems.

.3 Outline of proposed method of notification and correction of interim operational deficiencies.

.4 Outline of proposed demonstration and operator training program.

.4 Troubleshooting: Where problems become apparent during the commissioning process, work at the identification and resolution of these problems. The basic functions in trouble shooting are:

.1 What - Identification and definition of the problem.

.2 Why - Determination and evaluation of the causes.

.3 When - Determine the time available to resolve the problem.

.4 Involve the Cx Authority and Departmental Representative in the review of the problem and proposed resolution.

.5 Co-ordinate remedial action with the appropriate parties.

.6 Evaluate the effectiveness of the remedial action.

.5 Laboratory (Factory) Tests: If the field tests indicate that equipment supplied to the project does not meet specifications, laboratory certification of the potentially deficient equipment may be requested by the Cx Authority. In the event that equipment does not meet specifications, be responsible for the costs of:

.1 The above laboratory tests, and

.2 All subsequent testing and correction required.

.7 The work included in each of the four phases shall be generally as follows:

.1 PHASE 1 System readiness

.1 Before starting any of the separate systems, provide a certificate stating that the specific system is ready for start-up and the following conditions have been met (see also Section 23 06 02).

.1 All safety controls installed and fully operational (dry run test).

.2 Qualified personnel available to operate the plant.

.3 Permanent electrical connections made to all equipment.

.2 System readiness shall include, but not necessarily be limited to the following:

.1 Checking system physical completion, including all instrumentation.

.2 Flushing, chemical cleaning (as required), charging, fluid treating (as required).

.3 Equipment lubrication and prestart checks.

.4 Rotational checks.

.5 Air system cleaning complete.

.6 All D.X. systems checked for pressure and leakage.

.7 Filter systems installed and sealed in place.

.8 Adjusting vibration isolation and seismic restraints.

.9 Alignment of drives (direct and belt).

.10 Control function checks, including all alarms.

.11 Self diagnostic packaged control items checked.

.12 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently, corrected before proceeding to PHASE 2.

.2 PHASE 2 System start-up, testing, balancing

.1 System commissioning shall include, but not necessarily be limited to:

.1 Activation of all equipment and systems.

.2 Testing and adjustment of all equipment and systems.

.3 All deficiencies are to be recorded, reviewed by the commissioning team and, subsequently, corrected. The process at the point of the deficiency, shall be repeated before proceeding to PHASE 3.

.2 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:

.1 Balancing of the air systems as specified in this section.

.2 Balancing of the liquid systems as specified in this section.

.3 Set up air diffusers, registers and grilles for optimum distribution/comfort.

.4 Set up and test all implosion/explosion doors.

.5 Set up all automatic control valves/dampers and automatic temperature control devices.

.6 Set up constant volume and variable volume fans.

.7 Adjust air valves as necessary.

.8 Plug all air pressure and flow measuring holes.

.9 Adjust vibration isolators and earthquake restraints as necessary.

.10 Verification and certification of the sealing of all HVAC penetrations through fire separations (rated & non-rated) and sound separations.

.11 Verification of water tightness of all roof and exterior wall penetrations.

.12 Verification that all coil drain pans operate.

.13 Testing and debugging of B.A.S. (Building Automation System).

.14 Set up and test all alarm protective devices.

.15 Calibration and adjustment of the smoke venting.

.16 Power failure test with emergency generator start-up.

.3 Fine Tuning

.1 Setting up automatic controls for accurate response and precise sequencing.

.2 Correction of problems revealed by Balance Agency and change of motor speed and pitch as necessary.

.4 Testing

.1 A detailed check by a person having direct overall charge of commissioning. This check to include all items and functions to be later demonstrated to the Commissioning Authority, Departmental Representative.

.3 PHASE 3 Verification of System Performance

.1 Verification of system performance by the Commissioning Authority will not commence until PHASE 2 has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 The ease of access that has been provided throughout for servicing coils, motors, drives, fusible fire damper links, control and smoke dampers and damper operators.

.2 Location of and opening and closing of all access panels.

.3 Operability of randomly selected fire dampers.

.4 Operation of all equipment and systems, under each mode of operation.

.5 B.M.S. control features.

.6 Automatic controls.

.7 VFD Operation

.8 Rooftop equipment

.9 Gas fuel systems.

.10 Fans

.11 HVAC equipment

.12 Domestic water equipment

.13 Controls devices

.2 At the completion of Phase 3, the Contractor shall submit the following to the Commissioning Authority:

.1 A letter certifying that all work specified under this contract is complete, clean, and operational in accordance with the specification and drawings.

.2 A commissioning report which should include completed copies of all Phase 2 documentation outlined in the commissioning plan plus copies of start-up reports from specialty contractors and vendors and any other relevant information for inclusion in the operating & maintenance manuals.

.3 B.C. Gas Inspection Dept. approval of AHU on gas firing.

.4 Record drawings as specified, update to include changes resulting from commissioning.

.5 A statement confirming completion of B.M.S. acceptance test, Section 23 09 01.

.4 PHASE 4 Demonstration and Acceptance

.1 Demonstration and acceptance shall not commence until the commissioning process PHASE 3 has been successfully completed.

.2 The Demonstration process is a planned process requiring a preplan approval before commencement and a signed statement of satisfaction from the Departmental Representative upon completion.

.3 For Demonstration and instruction to Operating staff requirements, refer to this section of the specification and also to Section 23 09 01 (Controls General).

.5 Post Substantial Performance Visits

.1 Provide two follow-up visits to the site after substantial performance for a minimum period of three days each, to ensure that the systems are operating correctly and that they are being operated and maintained properly. Site visits shall coincide with peak winter and summer periods.

.2 Submit a report to the Commissioning Authority and Departmental Representative which documents any problems that have arisen and correction action required.

1.6 DEMONSTRATION AND INSTRUCTION TO OPERATING STAFF

.1 Provide certified personnel to demonstrate plant operation and to instruct operating staff on operation of mechanical equipment. Provide maintenance specialist personnel to instruct operating staff on maintenance and adjustment of mechanical equipment and any changes or modification in equipment made under terms of guarantee.

.2 The demonstration shall include:

.1 Operation and sequencing of all automatic control dampers and automatic temperature control devices.

.2 Operation of smoke venting and pressurization systems including smoke dampers and fire fighters control panel.

.3 Operability of randomly selected fire dampers.

.4 Operation and maintenance requirements of all equipment and systems under each mode of operation including, but not limited to:

.1 Automatic controls.

.2 Chilled water system.

.3 Hot water / glycol heating system.

.4 Cooling system.

.5 Fans.

.6 Coils.

.7 Pumps.

.8 Domestic water system.

.9 Other mechanical equipment and system

.3 Provide instruction during regular work hours prior to acceptance and turn-over to operating staff for regular operation.

.4 Use Operating and Maintenance manuals for instruction purposes.

.5 Submit the proposed instructional agenda for approval.

.6 Finalize demonstration and instructions by obtaining a signed statement from the Department Representative that the demonstration and instructions have been given satisfactorily. Forms in Section 23 06 02 should be used for this purpose.

1.7 SUBSTANTIAL PERFORMANCE REQUIREMENTS

.1 Before the Engineer is requested to make an inspection for substantial performance of the work:

.1 Commission all systems and prove out all components, interlocks and safety devices.

.2 Submit a letter certifying that all work (including calibration of instruments and balancing of systems) is complete, operational, clean and all required submissions have been completed. Form MF190 in Section 23 06 02 should be used for this purpose.

.2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:

.1 All reported deficiencies have been corrected.

.2 Testing and balancing completed.

.3 Operating and Maintenance Manuals completed.

.4 "As Built" Record Drawing ready for review.

.5 System Commissioning has been completed and has been verified by Departmental Representative.

.6 All demonstrations have been completed.

.7 All documents required on Form MF189, Section 23 06 02 have been submitted.

.3 Letters of assurance will not be issued until the following requirements have been met:

.1 All items listed in .1 and .2 above have been completed.

.2 Certificate of Fire Damper Installation (MF172).

.3 Certificate of Penetrations through separations (MF173).

.4 Gas Inspection - Certificate of inspection.

.5 Seismic Engineers letter of Assurance and final inspection report.

.6 Certificate of Substantial Performance (MF190).

.7 Signed off copy of final inspection report.

.8 Sprinkler and fire alarm test verification, sprinkler materials and test certificate and Engineers letter of Assurance.

.9 Plumbing Inspection report / card.

.10 Certificate of Backflow Prevention device.

1.8 DEFICIENCY HOLDBACKS AND DEFICIENCY INSPECTIONS

.1 Work under this Division which is still outstanding when substantial performance is certified will be considered deficient and a sum equal to at least twice the estimated cost of completing that work will be held back.

.2 It is expected that outstanding work will be completed in an expeditious manner and the entire holdback sum will be retained until the requirements for Total Performance of Division 22 and 23 work have been met and verified.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 23 08 00 – Mechanical Commissioning

.2 Section 23 05 93 – Testing, Adjusting and Balancing

1.2 NATURAL GAS SYSTEMS

.1 Operation tests:

.1 Measure gas pressure at gas meter outlet and at burner manifold.

.2 Verify details of temperature and pressure compensation at meter.

.3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.

.4 Check terminals of vents for gas pressure regulators.

1.3 REPORTS

.1 Provide TAB reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing.

.2 Provide Commissioning reports as specified in Section 23 08 00 – Mechanical Commissioning.

1.4 TRAINING

.1 Provide adequate time and resources to train the facility operators on the operation and maintenance of the following:

.1 HVAC systems

.2 Heating Water Systems

.3 Chilled Water Systems

.4 Refrigerant Systems

.5 Domestic Water Systems

.6 Control Systems

.7 Allow a minimum of 4 hours.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 Related Work

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

.2 This section shall review the shop drawings of the fire alarm system as provided by Division 26, with respect to the devices affecting the mechanical control system (an integral part of the Fire Fighters Central Control Facility).

1.2 General

.1 The control system is to be fully microprocessor based no pneumatic actuation will be permitted.

.2 The controls system is to be complete with all necessary control components and connections to achieve the specified functions and to permit the H.V.A.C. systems to perform properly in the manner described and as hereinafter specified.

.3 Coordinate and interface with the existing “Reliable” Building Automation System. Controls shall be provided by a firm that has experience with the existing “Reliable” BAS, firms include: Control Solutions, ESC Automation, Houle Electric.

.4 The controls contractor shall furnish all materials, including all central computer(s) hardware and software, operator input/output peripherals, standalone DDC panels, automation sensors and controls, wiring. The controls contractor shall be responsible for the design, installation, supervision and labour services, calibration, all software programming, and checkout necessary for a complete and fully operational Building Automation System. (Refer to section 23 09 24 for scope of work.)

.5 The control system is to be set up and adjusted to achieve optimum operation of the H.V.A.C. system. This includes sequencing, timing and readjustment, as required. Modifications to the sequence of operation using points indicated will not be considered as extra to the Contract. These modifications to continue through the construction period, commissioning period and warranty period as required to achieve optimum operation of the mechanical system.

.6 This Section is a performance specification clarified in certain sections to establish minimum standard of equipment, installation or level of control. The specification describes the basic functions required but not all of the installation details or components. This Trade is expected to have sufficient experience to be able to design and estimate the cost of an appropriate control system. Materials and work necessary to achieve a satisfactory result will not be considered extra to the contract.

.7 The contractor shall review all contract documents and visit the site if possible, prior to the closing date of the tender and site confirm the

requirements regarding the routing of interconnecting transmission network, etc.

.8 When preparing shop drawings, review the proposed sequences, suggest improvements and review these with the Departmental Representative.

.9 Work with the other parties involved in commissioning, assess how the programming can be modified to improve function, review this with the Departmental Representative and modify the programming as instructed by the Departmental Representative.

.10 The control system shall be a modular, flexible and fully commissioned Direct Digital Control (DDC) System except that controls not scheduled on the points list may be electric. Items identified in the sequence of operation as being under DDC control but which are not included in the points list shall be included in the DDC system.

1.3 Shop Drawings

.1 Submit shop drawings in accordance with Sections 01 33 00 and 23 05 00.

.2 Shop drawings shall include:

.1 Control centre layouts.

.2 Manufacturer's descriptive technical literature for all equipment and devices.

.3 Interconnection schematics.

.4 Wiring and piping diagrams.

.5 One-line diagram from sensor and control points to Field Interface device and/or standalone DDC panel including all components and cables.

.6 Terminal cabinets, including termination listing.

.7 Written description indicating sequence of operation. Shop drawings will be rejected if the written description is not included with the submission. Sequences should reference English descriptors and labels for each point described.

.8 All input/output points which shall include the following information associated with each point.

.1 Sensing element type and location.

.2 Details of associated field wiring schematics and schedules.

.3 Schematics and schedules.

.4 Software and programming details.

.9 Detailed block diagrams of transmission trunk routing and configuration.

.10 Valve and damper schedules indicating size, configuration, capacity and locations. If size varies greater than 10%, obtain approval of Departmental Representative.

.11 Copies of all system graphics complete with system specific point labels.

.3 When submitting the controls shop drawings arrange a time to review these in detail in the Departmental Representatives office.

1.4 Operating & Maintenance Manuals

.1 Refer to Division 1 (Section 01 78 00, clause 1.4 “Interactive Operating and Maintenance Manual System”) for additional requirements to those listed below. Division 1 requirements are to supersede any of the requirements listed below in case of requirements discrepancy.

.2 The maintenance manual data is intended to cover the operation and maintenance of all control systems and equipment installed. Forward 3 copies of the Controls and Instrumentation section of the operating and maintenance manuals to the Balancing Agency to ensure the binding and format of material are compatible. Ensure sufficient time has been given to the Balancing Agency for the compiling of the complete operating and maintenance manuals by the commissioning deadline. One complete manual shall be furnished prior to the time that system or equipment tests are performed.

.3 The manuals shall include the name, address and telephone number of the control subcontractor installing the systems and a list of emergency numbers for service personnel. The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject.

.4 Manuals shall be furnished which provide full and complete coverage of the following subjects:

.1 Operational Requirements: This document shall describe, in concise English terms, all the functional and operational requirements for the system and its functions that have been established. It shall not require knowledge of digital processor programming or electronic techniques or control system theory.

.2 System Operation: Complete guidance and procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats and procedures; and emergency, alarm, and failure recovery procedures. Provide step-by-step instructions for system start-up, back-up equipment operation, and execution of all system functions and operating modes.

.3 Functional Description: Detailed documentation, in language readily understandable to engineering personnel, of the theory of operation and specific functions of the system. Provide full details of data communications, including data types and formats, data processing and disposition data link components and interfaces and operator test or self-test of data link integrity for all system components and computer peripherals during each system function and operating mode. Hardware and software functions, interfaces, and requirements shall be explicitly detailed for all system components in all system functions and operating modes. Any operating procedures currently implemented or planned for implementation in an automatic mode shall be stated and described.

.4 Software: Documentation of the theory, design, interface requirements, and functions of all software modules and systems for all digital processors. Include test and verification procedures and detailed descriptions of program requirements and capabilities. Provide all data necessary to permit modification, relocation, or other reprogramming and to permit combination of new and existing software modules to respond to changing system functional requirements without disrupting normal control system operation. Include, as a minimum, for all software modules, fully annotated source code listings, error-free object code files ready for loading via a peripheral device, and complete program cross reference, plus any calling requirements, data exchange requirements, necessary subroutine lists, data file requirements, and other information necessary to ensure proper loading, integration, interfacing, and program execution. All DDC panel software shall be provided individually for each DDC panel while a single section shall reference all DDC panel common parameters and functions.

.5 Maintenance: Documentation of all maintenance on all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective units. Include calibration, maintenance, and repair of all sensors and controls, plus diagnosis and repair or replacement of all system hardware.

.6 Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as Test Procedures. A provision for the measurement or observation results, based on the previously published Test Specification, forms the Test Reports. The procedures record and the results of these exercises shall be conveniently bound and documented together.

.5 Refer to Section 23 05 00 for additional requirements.

1.5 Warranty

.1 Refer to General Conditions.

.2 The system including all hardware and software components shall be warranteed for a period of one year following the date of final acceptance. Any manufacturing defects arising during this warranty period shall be corrected without cost to the Departmental Representative.

.3 All applicable software as detailed in this specification shall be updated by the Controls Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the Controls Contractor. All future patches to the software shall be made available to the Departmental Representative.

.4 Repairs required by a total system failure, or the malfunction of any priority portion of the system shall be considered an emergency repair, and shall be performed within eight (8) hours of the report of the failure.

.5 Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.

.6 Provide written assurance that a local service centre will be maintained with a complete stock of replacement parts, and capable of servicing any and all troubles in the system.

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

.8 Take note of and provide any extended warranties specified.

1.6 Electrical Components, Wiring and Conduit

.1 By Control Contractor (Division 23):

.1 All control system components to make a complete and operable system, except those supplied as part of packaged equipment controls, but including all auto- sequencing devices and electrical interlocks required to accomplish the sequences specified hereafter. Refer to the electrical equipment schedule, the electrical drawings and the electrical specification, which describes the limits of the extent to the work in Division 26 serving mechanical systems. Materials, equipment, connections and power not provided by Division 26 but required for the Control System shall be provided under this section.

.2 All control circuit transformers (120/1/60 or 24/1/60 and as designated).

.3 All control wiring and metallic conduit for mechanical system controls.

.4 Supply, installation and connection of all electric control items including: damper motors, relays, outside sensors, sub-master control circuits, safety devices, electric thermostats, aquastats, flow switches, wiring to terminal strips, proportional controllers, controllers, etc.

.5 All wiring and conduit from power distribution system to any control devices needing power (including B.A.S. components)

.6 Be responsible for coordinating with Division 26.

.7 Electrical work installed under Division 23 shall be to the standards specified under Division 26.

.2 By Division 26:

.1 All power wiring and conduit from power distribution system up to and including connection to all motors and starters.

.2 All disconnect switches required (unless specified in schedules as being integral with equipment).

.3 All motor protection switches, stop-start switches, magnetic starters, contactors and hand-off-automatic selector switches except those supplied as part of packaged equipment.

.4 Terminal strips within the motor control centres (MCC) for control connections.

.5 Fire alarm signals.

.3 Note:

.1 All magnetic starters for equipment shall have the following features supplied under Division 26:

.1 Hand-off-automatic selector or on-off selector, or start-stop buttons in cover with hand-automatic bridge if applicable.

.2 Pilot light.

.3 120 volt coils.

.4 120 volt control transformer.

.5 Four auxiliary dry contacts for interlocks; two normally open and two normally closed.

.2 The Controls Contractor is responsible for reading Division 26 plans and specifications to determine scope of responsibility and standards.

.4 Wiring:

.1 Carrier System:

.1 All wiring shall be run in EMT conduit except the final 900mm of wiring to all operators and to all sensors subject to vibration, which shall be run in flexible metallic conduit.

.2 Provide steel fittings with nylon throats for all conduit connections.

.2 Wire:

.1 Line voltage power or switched power wiring - #12 gauge copper wire minimum.

.2 Line voltage control wiring - #14 gauge copper wire, length not to exceed 50 meters; #12 gauge copper wire, lengths exceeding 50 meters.

.3 Low voltage - minimum #22-gauge wire as directed by applicable electrical codes and requirements. 24-gauge wire for thermostat cables

.3 Cable:

.1 Data transmission cable shall be minimum #18 gauge twisted pairs (shielding as per manufacturers recommendations).

.4 Note:

.1 Run carrier system parallel to building lines.

.2 Support conduit carrier system every one meter independent of piping, ductwork and equipment.

.3 All wiring shall be concealed in finished spaces.

.4 Seal all penetrations through fire separations or walls as per code requirements.

.5 Identify all junction box covers with control company label.

.6 Identify with colour bands, all conduits at all junction and pullboxes, at both sides of wall and floors and at not more than 7.5 m [25 Ft] intervals along the length. Identification bands to be sprayed on and not less than 100mm [4"] wide. Bands to be pink in colour unless in conflict with Division 16 colours.

.7 Use colour coded conductors.

.8 Adhere to all applicable electrical codes and regulations.

.9 Obtain electrical permit.

.10 For non-CSA equipment where required by electrical code, submit to Inspection Authorities and obtain approval prior to installation of equipment on site.

1.7 Equipment Supplied for Installation Under Other Sections

.1 The following equipment shall be supplied under this section but installed under the appropriate trade sections of Division 23:

.1 Automatic control valves.

.2 Temperature sensor wells.

.3 Automatic control dampers.

.4 Pressure tappings.

.5 Static pressure sensors.

.6 Flow switches.

.7 And other as called for in mechanical documents.

.2 The Controls Subcontractor shall be responsible for arranging, coordinating and supervising the installation of the above devices in a suitable manner and readily accessible location.

1.8 Freeze Protection

.1 All air supply handling units containing coils shall have a non-recycling, manual reset, electric line voltage freeze protection controller that will stop the system upon sensing 4°C.

.2 The freeze protection controllers shall contain an additional set of dry contacts that will close on freeze detection for remote alarm indication at the B.A.S.

.3 The freeze protection contacts shall be connected on the common line after the H.O.A. selector switch.

1.9 Alarms - General

.1 No alarm shall be triggered for a device until the device has been started and is in stable operation. Use software time delays to achieve this effect.

.2 Generate an alarm on the B.A.S. if any equipment is not in the intended operating condition or if any analog input is not within the intended operating range.

1.10 Identification

.1 Identify all controls with symbols relating directly to the control diagram. Use plasticized tags, engraved brass, aluminum, metalphoto or lamicoid labels and secure them to, or adjacent to, the control devices with key chains or cable ties.

.2 All manual switches supplied by the trade, unless they come with standard nameplates, shall be labelled with engraved lamicoid plastic nameplates to clearly indicate the service. Wording on nameplates shall be subject to approval by the Departmental Representative.

.3 Where "day" and "night" thermostats are adjacent to one another they shall be labelled with engraved lamicoid plastic nameplates.

.4 Motor control centre and motor starters should be provided with labels identifying that motors are under remote control.

.5 Mount an input/output layout sheet within each main DDC panel. This sheet shall include the name of the points connected to each controller channel.

.6 Identify all DDC panels and associated devices with symbols relating directly to the control diagram. Provide durable wire labels for each input and output point with the following information:

.1 Point descriptor.

.2 Point type and channel number.

.3 Corresponding DDC panel number.

1.11 System Commissioning and Calibration

.1 Program each standalone DDC panel immediately following installation.

.2 Set up and calibrate all control loops and sensors during the initial start-up of the systems and check, recalibrate and readjust as necessary during the Demonstration and Instruction period.

.3 Upon completion of the installation, perform all necessary testing and debugging operations satisfactorily.

.4 Perform all modifications and alterations as required to correct any deficiencies noted during these tests.

.5 Check sensor calibration and control system operation during the first heating season and prior to the first cooling season.

.6 Following each visit submit printed graphs of trend logs one week in duration with hourly samples for all analog inputs connected to each DDC panel.

1.12 Verification of System Commissioning

.1 Preliminary Tests

.1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.

.2 Notify the Departmental Representative in writing at least seven days before testing is to take place stating the following:

.1 Location and part of system to be tested.

.2 Describe testing procedure and anticipated results.

.3 Provide all necessary testing equipment and personnel.

.4 Provide portable 2-way radios for communications during demonstrations. Provide three units on the same frequency and of sufficient power and quality as to be useful throughout the building.

.5 Perform tests in presence of the Departmental Representative.

.6 Demonstrate the proper operation of each component.

.7 Correct any deficiencies and re-test in the presence of the Departmental Representative, until designated part of the system performs satisfactorily.

.2 Final Operational Acceptance Test

.1 A final operational test of not less than thirty (30) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total installed and operational Control System to demonstrate that it is functioning properly in accordance with all requirements of this specification. The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software. If the equipment operates at an average effectiveness level (AEL) of at least 95% during the performance test period of thirty (30) consecutive calendar days, it will be deemed to have met the Acceptable Standard of Performance, and final acceptance of the system shall be made, provided the contractor has satisfied all other requirements of this specification. In the event the required AEL is not reached during the initial thirty (30) consecutive calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for thirty (30) consecutive calendar days. The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period. Downtime shall result whenever the control system is unable to fulfill all required functions detailed within this specification due to any malfunction of either BMS hardware or software. Any defect of hardware or software shall be corrected when it occurs before the test may be resumed. Downtime created by non-BMS equipment or activities will not be considered as downtime for the AEL calculation.

1.13 Demonstration and Instruction to Departmental Representative

.1 The Controls Contractor shall provide the services of competent instructors who will give full instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general (canned) training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum. A training manual shall be provided for each trainee which describes in detail the data included in each training program. All equipment and material required for classroom training shall be provided by the Contractor.

.2 Training Program: The training program shall be accomplished in two phases.

.1 First phase: this phase shall be for a period of at five days at a time mutually agreeable between the Contractor and Departmental Representative. Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. First phase training shall include the following:

.1 General control system architecture.

.2 System communications.

.3 Operation of computer and peripherals.

.4 Elementary preventative maintenance.

.5 Report generation.

.6 Operator control functions.

.7 Colour graphics generation.

.2 Second phase: this phase of training shall be conducted four to eight weeks after system acceptance for a period of three days. The training shall include as a minimum, but not be limited to:

.1 A review of Phase 1 training.

.2 Equipment maintenance - this training shall include:

.1 General equipment layout.

.2 Trouble shooting of all control system components.

.3 Preventative maintenance of all control system components.

.4 Sensors and controls maintenance and calibration.

.3 Programming - this training shall include:

.1 System architecture.

.2 Application programs.

.3 DDC panel programming.

.4 Software access code review.

1.14 Maintenance Service During the Warranty Period

.1 The Contractor shall provide all services, materials and equipment necessary for the maintenance of the entire Control System, for a period concurrent with the warranty period. Any necessary material required for the maintenance work shall be provided by the Contractor.

.2 The Controls Contractor shall provide one minor inspection per quarter or as required by the manufacturer and two major inspections per year, and all service for the required maintenance.

.3 Major Inspections: these inspections shall include but not be limited to the following:

.1 Work as detailed hereinafter for minor inspections.

.2 Clean all peripheral equipment, CPU, interface panels, multiplexing panels and micro processor interior and exterior surfaces.

.3 Provide signal, voltage and system isolation checks of all CPU, interface panels, multiplexing panels and peripherals.

.4 Provide mechanical adjustments, new ribbons and necessary maintenance on printers.

.5 Check and/or calibrate each field input/output device.

.6 Run system software diagnostics as required.

.4 Minor Inspections: These inspections shall include but not be limited to the following:

.1 Provide visual and operational checks to all CPU, peripheral equipment, interface panels, multiplexing panels, and field devices.

.2 Change filter and check fan for all CPU's peripheral equipment as required.

.3 Provide complete back up of BMS system.

.4 Regular service calls: these calls shall be performed during regular working hours, 8:00 a.m. to 4:30 p.m. Monday through Friday excluding legal holidays.

.5 Emergency Service: the Departmental Representative will initiate service calls when there is indication that the control system is not functioning properly. The Contractor shall have qualified control personnel available during the warranty period to provide service to the "critical" control system components whenever required at no additional cost to the Departmental Representative. The Contractor shall furnish the Departmental Representative with a telephone number where the service mechanic can be reached at all times. The service mechanic shall be on the job ready to service the control system within the next eight (8) hours, after receiving a request for service and the work shall be performed continuously until the control system is back in reliable operating condition. Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.

.6 Records and Logs: records and logs shall be kept of each maintenance task.

.7 System Modifications: recommendations for system modification shall be provided in writing to the Departmental Representative. No system modification, including operating parameters and control settings, shall be made without prior approval.

.8 Software: provide implementation of all software maintenance updates. These shall be accomplished as required and full coordination with control system supervisory personnel shall be maintained.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 GENERAL REQUIREMENTS

.1 Coordinate and interface with existing "Reliable" Building Automation System.

.2 Provide all remote sensing points and instrumentation as required for the complete operational capability of the Control System. All sensors shall have the accuracies as stated hereinafter. Hysteresis, relaxation time, span, maximum / minimum limits, etc. shall also be accounted for in all application of sensors and controls.

.3 All instruments of a particular category shall be of the same type and manufacture.

.4 All external trim material shall be completely corrosion resistant with all internal parts assembled in watertight, shockproof, vibration proof, heat resistant assembly.

.5 Use standard conduit box termination with screwdriver connector block unless otherwise specifically stated.

.6 Operating conditions 0°C to 60°C with 10-90% RH (non-condensing) unless otherwise specifically stated.

Part 2 Products

2.1 AIR VALVE CONTROLLERS

.1 Microprocessor based terminal unit controllers (TUC's) and damper actuators for the air valves will be supplied by the Controls Contractor. The TUC's shall be provided in a pre- assembled control box for mounting on the air valve. The multi-point flow sensor shall be supplied and installed by the air valve manufacturer.

.2 The necessary interface requirements for the multi-point flow sensor shall be provided by the Controls Contractor (confirm exact requirements with the air valve manufacturer).

.3 Controller and actuator shall be factory mounted on the air valve by the air valve manufacturer.

.4 The Controls Contractor shall be responsible for ensuring that the controllers and damper actuators are suitable for the units and that the characteristics of the boxes listed herein are met.

.5 Controls arranged for pressure independent, variable volume and constant volume operation.

.6 Resettable to any air volume between zero and maximum rated volume.

.7 The Controls Contractor shall provide all necessary assistance to air valve manufacturer for factory / laboratory testing of air valves. One unit of each size air valve shall be factory tested under varying pressure and flow conditions.

.8 Refer to Section 23 09 24 for TUC specifications.

.9 Refer to Section 23 34 00 for air valve specifications.

2.2 CURRENT SENSING (CR)

.1 Design: Best Coil D78009; Nelsen-Kuljian; Greystone, Veris, or equivalent.

.2 Range: 0-120 amps.

.3 Accuracy: +/-1%.

.4 Interface care:

.1 +/-1% accuracy.

.2 Integral zero and span adjustment.

.3 1-5 VDC or 4-20 mA output for full range input.

2.3 CONTROL AND SMOKE DAMPERS

.1 Minimum Requirements:

.1 Provide control dampers configured as follows:

.1 Modulating; opposed blade dampers.

.2 Mixing; parallel blade dampers.

.3 Two position; parallel blade dampers.

.2 Assemblies - rigid and adequately braced with corner gussets.

.3 Galvanized steel or extruded aluminum frames.

.4 Maximum frame dimensions - 1220 mm [48"] wide and 1220 mm [48"] high, unless otherwise indicated. Multiple sections to have stiffening mullions.

.5 Maximum blade width - 200 mm [8"].

.6 Galvanized coating on all sheared edges of galvanized steel frames and blades exposed to outside atmosphere.

.2 Standard control dampers:

.1 Minimum performance, based on 610x610 [24"x24"] damper size as tested in an independent testing laboratory:

.1 Maximum 0.35" static pressure drop at 3000 fpm velocity (damper fully open).

.2 Maximum 10.75 cfm/sq.ft. Leakage at 3" w.g. (Damper fully closed).

.3 Suitable for –40oC to 116oC [-40oF to 116oF] operating range.

.4 Maximum blade length of 1219mm [48"] suitable for minimum 2.5" w.g. and 1500 fpm velocity.

.2 Minimum 1.6mm [16 ga] single skin galvanized steel blades with longitudinal groove reinforcement.

.3 Synthetic sleeve type bearings (no metal to metal contact).

.4 Linkage concealed within the damper frame.

.5 Square or hexagonal axles locked into blades.

.6 Synthetic rubber or PVC coated fabric seals mechanically locked into the blade edge (adhesive or clip-on type seals not acceptable).

.7 Flexible metal compression type or extruded synthetic rubber jamb seals.

.8 Standard of Acceptance: Ruskin CD36, or equivalent.

.3 Low leakage control dampers:

.1 Minimum performance, based on 610x610 [24"x24"] damper size as tested in an independent testing laboratory:

.1 Maximum 0.25" static pressure drop at 3000 fpm (damper fully open).

.2 Maximum 10.75 cfm/sq.ft. Leakage at 3" w.g. (Damper fully closed).

.3 Suitable for –40oC to 100oC [-40oF to 212oF] operating range.

.4 Maximum blade length of 1219mm [48"] suitable for minimum 4" w.g. And 3000 fpm velocity.

.2 Minimum 2.0mm [14 ga] galvanized steel airfoil type or 2.1mm [12 ga] extruded aluminum airfoil type blades.

.3 Synthetic sleeve type bearings (no metal to metal contact).

.4 Linkage concealed within the damper frame.

.5 Square or hexagonal axles locked into blades.

.6 Synthetic rubber blade seals mechanically locked into the blade edge (adhesive or clip-on type seals not acceptable).

.7 Flexible metal compression type or extruded synthetic rubber jamb seals.

.8 Standard of Acceptance: T A Morrison 1000, Arrow-Foil PBDAF & OBDAF, Honeywell Moduflow D642 & D643, Johnson Proportion/Aire D-1200 & D-1300, Ruskin CD36, Tamco 1000, Nailor 1010, or equivalent.

.4 Smoke control dampers:

.1 Smoke dampers to be labelled to ULC Standard CAN/ULC S112.1-M90 and UL 555S leakage class 1. Standard of acceptance: Ruskin SD50, or equivalent.

.2 Actuators for smoke dampers shall be supplied with the smoke dampers as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Actuators shall be rated for 177oC [350oF] elevated temperature classification. Actuators shall be mounted so that the damper fails to the closed position (spring return) - Electric or pneumatic.

.3 Smoke dampers shall be equipped with two position indicator switches linked directly to the damper blade.

.5 Note:

.1 Control dampers integral to air handling and heat recovery units provided and factory installed by the unit supplier (actuators by this division). All other control and smoke dampers by this division.

.2 Instruct the Sheet Metal Trade on damper installation.

.3 Indicated size is outside frame dimension. Increase size of damper and oversize ductwork, to include for depth of the frame, for all dampers with a pressure drop greater than 12 Pa [0.05" w.g.]. Confirm with Section 23 31 00 before fabrication.

.4 Check that dampers are installed square and true and that blades close tightly against seals and stops.

.5 Blades to be horizontal in vertical mounted dampers. Refer to drawings for orientation of dampers.

.6 Ensure that damper end-linkages are easily accessible (coordinate with Section 15800).

.7 Provide an additional drive shaft bearing if the drive shaft is longer than 75 mm [3"].

.8 Do not install dampers within the thickness of any wall unless otherwise indicated (coordinate with Section 23 31 00 & 23 33 00).

.9 Dampers shall be adequate for the maximum system pressure. Refer to the appropriate section of the specification.

2.4 CONTROL DAMPERS - ROUND

.1 Standard of Acceptance:

.1 Ruskin CDRS-25, or equivalent.

.2 Minimum Requirements:

.1 1.19 mm thick [18 ga.] galvanized steel frame with rolled stiffener beads.

.2 Damper blade constructed from two layers of galvanized steel with neoprene edge seal sandwiched between layers.

.3 Stainless steel bearings.

.4 Air leakage shall not exceed 0.28 L/s per 100 mm of blade circumference at 1.0 kPa [.15 CFM per inch of blade circumference at 4" W.C.].

2.5 CONTROL VALVES

.1 All characteristics of control valves shall be suited to the required application. Three- way mixing valves shall be linear for each port giving constant flow, and two-way valves shall have modified linear flow characteristics.

.2 All valves shall be plug type with stainless steel stems and EPT ring pads or teflon packing.

.3 Valve pressure / temperature rating - minimum ANSI Class 125.

.4 Plugs shall be brass with molded composition discs.

.5 Discs (renewable) shall be bronze for media 110□C or less and stainless steel for media above 110□C operating temperature.

.6 Valve bodies for NPS ½ shall be screwed cast brass with integral seat.

.7 Valves NPS 3/4 to NPS 2 shall have screened cast brass body and cast brass cage with integral seat.

.8 Valve bodies for NPS 2-½ and up shall be cast iron flanged.

.9 All control valves supplied with positive positioning relay shall have a minimum of 27- 76 kPa spring range.

.10 Note:

.1 Size control valves according to capacities and pressure drops as indicated in the schedules.

.2 Clearly identify the control valve coefficient (Cv) rating on valve bodies.

.3 All primary building heating valves shall fail open to heating (valves on terminal units may fail either open or to the last operating position). Cooling valves shall fail closed to cooling or to the last operating position. Domestic hot water heating valves shall fail closed to heating.

.4 Control valves to be supplied by this trade for installation by others.

.11 Design: NPS ½ to NPS 2 - Johnson Controls VG7000 series. NPS 2-½ and larger - Johnson Controls cast iron flanged globe valves V5252, V5842; or equivalent.

.12 Acceptable Manufacturers: Honeywell V5011 and V5013 series (V5812 series for terminal units); Barber Colman 9213 and 9313 series; Landis & Gyr Powers 656, 658, 591, 592, 593 series; or equivalent.

2.6 CONTROL VALVE ACTUATORS

.1 General:

.1 Valve operators shall allow smooth operation of the valve throughout its entire range and assure tight shut-off against system pressure.

.2 Valve actuator shall be easily removed from the valve body for replacement.

.2 Electric Two Position Valve Actuators (VTE):

.1 Two Position Control Valve Actuators (only to be used where specifically specified):

.3 Incremental Control Valve Actuators (only to be used where specifically specified) (VMI):

.1 The valve actuator shall modulate the control valve between the fully open and closed position based upon a 3-wire control signal (24 VAC). The actuator shall remain in position until the signal is applied.

.2 The valve shall maintain its shutoff force even if power is lost.

.3 The TUC shall calculate valve position based on the motor speed and duration of control signal. The valve shall be driven to a full position and the calculation reset once every 24 hours.

.4 Proportional Control Valve Actuators (VME):

.1 The valve actuator shall modulate the control valve between the fully open and closed position based upon a 0-10 VDC or 4-20 mA control signal. The actuator shall remain in its position until the applied signal changes. In the event of a control signal loss, the actuator shall move to the zero voltage input position.

.2 The valve shall maintain its shutoff force even if power is lost.

2.7 CONTROL PANELS

.1 General:

.1 Fabricate from prime and enamel coated steel suitable for flush

mounting, complete with mounting legs.

.2 Panel doors shall be hinged and complete with locks.

.3 Construct so that instruments and gauges are flush mounted.

.4 Provide sub-panel, inside control panel, for mounting control components.

.5 Adhere lamicoid nameplates on the control panels to clearly identify the service of each device.

.6 Submit shop drawings of control panel for review.

2.8 DIFFERENTIAL PRESSURE TRANSMITTERS (DPT)

.1 Provide differential pressure transmitters having the following minimum specifications:

.1 Internal materials to be suitable for continuous contact with the process material measured including compressed air, water, glycol or steam as applicable.

.2 Output signal of 4 - 20 mA into a maximum of 500 ohm load.

.3 Output variations of less than 0.2% full scale for supply voltage variations of +/- 10%.

.4 Combined non-linearity, repeatability and hysteresis effects not to exceed +/- 1% of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effect of +/- 1.5% full scale/50□C or less.

.7 Output short circuit and open circuit protection.

.8 Over-pressure input protection to a minimum of twice rated input.

2.9 DAMPER ACTUATORS

.1 General:

.1 Provide 120 or 24 volt electric damper actuators where indicated or required.

.2 Damper actuators for all fan variable volume devices, all control dampers and all smoke/fire dampers shall be supplied by this trade. Refer to Section 15960 or the drawings for schedule of control and smoke/fire dampers.

.3 Damper actuators for air valves shall be supplied by this trade for factory installation by unit manufacturer. Damper actuators shall meet the requirements of the unit manufacturer in all cases.

.4 Spring return for "fail-safe" in Normally Open or Normally Closed position where required.

.5 Size actuators to control dampers against maximum pressure or dynamic closing pressure whichever is greater.

.6 Size damper actuators so that they will provide smooth and full travel of the dampers while stroking in both directions.

.7 Where individual dampers are installed, install a separate damper actuator for each damper.

.8 Where multi-section dampers are installed, install a separate damper actuator for each section.

.9 Locate damper actuator so that they are easily accessible for testing and servicing.

.10 Where damper actuator operates outdoor and exhaust air dampers, pretension the damper drive linkage to ensure tight closure.

.11 Where a damper actuator is installed on an insulated surface of a duct or plenum, mount it on a stand-off bracket, so as not to interfere with the continuity of the insulation.

.2 Electronic Damper Actuators (DME & DTE):

.1 Actuators shall be direct coupled enabling it to be mounted directly to the damper shaft without the need for connecting linkage.

.2 The actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

.3 Proportional actuators shall accept a 2 to 10 VAC or 4 to 20 mA signal.

.3 Incremental Control Damper Actuator (DMI):

.1 For VAV box damper control only.

.2 The damper actuator shall modulate the damper between fully open and fully closed based on a 3-wire control signal (24 VAC). The actuator shall remain in position until the signal is applied.

.3 The TUC shall calculate damper position based on the motor speed and duration of control signal. The damper should be driven to a full position and the calculation reset once every 24 hours.

2.10 END SWITCHES (ESW)

.1 Provide CSA approved end switches on all Smoke and all Combination Fire/Smoke dampers and where indicated.

.2 End switches shall provide positive status indication of full open and full closed blade position. Provide 2 switches per damper if necessary.

2.11 ELECTRIC RELAYS (ER)

.1 Provide DPDT relays for control and status indication of alarms and/or electrical starters and equipment.

.2 Relay coils shall be rated for 120V or 24V. Where other voltages occur provide transformer.

.3 Contacts rated at 5 amps at 120V AC.

.4 Relays to be plug in type with termination base.

2.12 FLOW SWITCHES (FSW)

.1 Acceptable Manufacturers:

.1 McDonnell Miller, Johnson Controls, or equivalent.

.2 Minimum Requirements:

.1 Single pole double throw action (vapour proof on chilled water).

.2 Adjustable sensitivity.

.3 Extended trimmable paddles.

.4 Selected for minimum flow condition.

.3 Notes:

.1 Install in upright position in horizontal run of pipe.

.2 Install a minimum of 5 pipe diameters downstream of any valves, elbows, orifices or any other obstructions.

.3 Adhere to manufacturer's installation recommendations.

2.13 PRESSURE SWITCHES (PSW)

.1 Provide pressure or differential pressure switches for ranges as indicated.

.2 Pressure sensing elements shall be Bourbon tube, bellows or diaphragm type.

.3 Adjustable set-point and differential.

.4 Pressure switches shall be snap action type rated at 120 volts, 15 amps AC or 24 volts DC.

.5 Sensor assembly shall operate automatically and reset automatically when condition returns to normal.

.6 Sensor Ratings: sensors shall have the following pressure and accuracy ratings:

.1 Low and medium steam sensors shall be rated at 1030 kPa. Low pressure shall operate from 0 to 207 kPa with an accuracy of plus or minus 3 kPa. Medium pressure shall operate from 0 to 700 kPa and with an accuracy of plus or minus 7.0 kPa.

.2 High pressure steam sensors shall be rated at 2100 kPa, have a full

operating range of 0 to 2100 kPa with an accuracy of plus or minus 14 kPa.

.3 Pressure switches for pump operation shall have a range of 20 kPa to 350 kPa and adjustable differential from 1 kPa to 35 kPa.

.4 Pressure switches for fan operation shall have a range of 0 to 1500 Pa and adjustable differential from 10 to 50 Pa.

.5 Sensors on steam lines and high temperature water shall be protected by pigtail siphon installed between the sensor and the fluid line.

.6 All sensors shall have an isolation valve and snubber installed between the sensor and pressure source.

2.14 STATIC PRESSURE TRANSMITTERS (SPT)

.1 Output of 4 - 20 mA linear into maximum of 500 ohm load.

.2 Calibrated span: not greater than twice the static pressure at maximum flow.

.3 Accuracy: +/- 1% of span.

.4 Repeatability: within 0.5% of output.

.5 Linearity: 1.5% of span.

.6 Deadband or Hysteresis: 0.1% of span.

2.15 TEMPERATURE SENSORS

.1 General: Temperature sensors shall be thermistor, resistance or thermocouple type. However, thermocouples shall be restricted to temperature range +200°C and above.

.2 The following shall apply to thermistor, resistance or thermocouple temperature sensors as applicable.

.1 RTDs shall be 100 ohm or 1,000 ohm at 0øC (+/- .2 ohm) nickel or platinum element with strain minimizing construction and 3 integral anchored leadwires coefficient of resistivity of 0.000385 ohms/ohm/ deg.C. Thermistors shall be 3,000 or 10,000 ohms.

.2 Sensing element to be hermetically sealed.

.3 Stem and tip construction to be copper or 304 stainless steel as noted.

.4 Sensors to have a time constant response of less than 3 seconds to a temperature change of 10□C.

.5 Sensors shall operate over the following ranges with the accuracies over the noted range of the sensor.

.1 -50°C to +50°C, plus or minus 0.5°C.

.2 0°C to +50°C, plus or minus 0.25°C.

.3 0°C to 25°C, plus or minus 0.1°C.

.4 0°C to 100°C, plus or minus 1°C.

.6 Immersion wells shall be of stainless steel materials for steam and domestic hot water and brass for other applications. Heat transfer compound to be compatible with sensor.

.3 Temperature sensors shall be of the following types:

.1 Room type (RTS) - suitable for wall mounting, with or without protective guard. Element length of 10-50 mm with ceramic tube or equivalent mode of mechanical protection.

.2 General purpose duct type (DTS) - suitable for insertion into air ducts at any angle, insertion length shall be suitable for application. Copper sheathed construction.

.3 Spring-loaded thermowell type (ITS) - spring loaded construction with compression fitting for 20 mm NPT well mounting. Lengths shall be suitable for application. Stainless steel sheathed construction.

.4 Averaging duct type (ATS) - continuous filament with immersion length of 6000 mm minimum. Probe to be bent, at field installation time, to a minimum radius of 100 mm at any point along the probe length without degradation in performance. Copper sheathed construction.

.5 Outside air type (OTS) - complete with non-corroding shield designed to minimize solar and wind effects, threaded fitting for mating to 12 mm conduit, probe length of 100 - 150 mm.

2.16 TEMPERATURE SWITCHES (TSW)

.1 Provide high/low temperature switches for ranges as indicated on point schedule.

.2 Temperature sensing element shall be liquid, vapour or bimetallic type.

.3 Adjustable set-point and differential.

.4 Snap action type rated at 120 volts, or 24 V DC as required.

.5 Sensors shall operate automatically and reset automatically. Sensors used for freeze detection or fire detection shall be manually reset type.

.6 Temperature accuracy shall be +/-1°C.

.7 Temperature switches shall be of the following types:

.1 Room type - suitable for wall mounting on standard electrical box with or without protective guard.

.2 General Purpose Duct type - suitable for insertion into air ducts, insertion length of 457 mm.

.3 Thermowell type - with compression fitting for 20 mm NPT well

mounting, length of 100 mm. Immersion wells shall be brass (stainless steel for domestic water and steam).

.4 Freeze detection type - continuous element with insertion length of 6000 mm minimum, suitable for duct mounting to detect the coldest temperature in any 30 mm section of its length.

.5 Strap-on type - with helical screw stainless steel clamps.

2.17 VELOCITY PRESSURE TRANSMITTERS (VPT)

.1 Output of 4 - 20 mA linear into maximum of 500 ohm load.

.2 Calibrated span: not greater than twice the static pressure at maximum flow.

.3 Calibrated accuracy: +/- 1.0% of span.

.4 Repeatability: within 0.1% of output.

.5 Linearity: 0.5% of span.

.6 Deadband or Hysteresis: 0.1% of span.

2.18 VARIABLE SPEED DRIVE CONTROLLER

.1 Minimum Requirements:

.1 Unit to operate with an input, line side power factor of 0.94 or better at all speeds and loads.

.2 All units supplied to the project must be of the same manufacturer and model type.

.3 Factory C.S.A. certified.

.4 Unit to operate in ambient temperatures ranging from 0o C to +40o C.

.5 Unit to operate at full load with a variation of -15% and +10% of rated building voltage.

.6 Unit to operate at full load with a variation of +5% of rated frequency.

.7 Printed circuit board design using the latest "state of the art" components including microprocessor control of protective circuits.

.8 Suitable for use with the standard or high efficiency EEMAC Design B motors used on this project.

.9 VSD module and all additional peripheral components as specified herein, to be integrated and mounted in one common EEMAC 1 (use EEMAC 3R for outdoor units) wall or floor mounted enclosure.

.10 Transformers shall not be used on either the input or output of unit.

.11 The VSD shall have an adjustable PWM carrier/switching frequency

from nominal 1 through 12 kHz. Units unable to adjust to a minimum upper level of 12 kHz are not acceptable. Maximum switching frequency of 16 kHz.

.12 The VSD shall include reactors or LRC filters as necessary to protect the motor from PWM - IGBT voltage spikes and limit the voltage rise times and maximum peak voltages throughout the specified building voltage range and for all operating conditions at the related motor connections as follows:

.1 Maximum peak voltage 1000 volts.

.2 Maximum voltage rate of rise: 500 volts/microsecond.

.13 Unit shall be provided with protection against:

.1 Stalls caused by overcurrent.

.2 Stalls caused by regenerative overvoltage.

.3 Overcurrent protection.,

.4 Regenerative overvoltage protection.

.5 Overload protection (thermal type).

.6 Ground fault protection.

.7 Instantaneous power failure protection.

.8 Alarm against overload.

.9 Overtemperature of heat sink.

.10 Input power under voltage, over voltage and phase loss.

.11 DC bus over voltage.

.14 The unit shall have the following features:

.1 Adjustable acceleration and deceleration. Across the line starting shall not be possible. A ramp up time from 0 RPM to 1800 RPM of 30 seconds shall be the minimum possible ramp up time.

.2 Dynamic breaking for acceleration and stopping.

.3 Critical speed avoidance will allow for the selection of two skip speeds and a rejection band of 0 – 10Hz around each speed.

.4 Voltage/frequency ratio and adjustment.

.5 Power failure restart to be selectable and programmable for number of attempt's & time interval between attempt's. Unit also to have circuits to permit a start into a rotating motor, in either direction without trip or failure.

.6 Frequency range (output) 2 - 60 Hz minimum.

.7 Frequency resolution of 0.5 Hz or better.

.8 Frequency accuracy of +/-0.5% at 25□C.

.9 Able to accept a 4-20 milliamp, 0 to 5 vdc or 0 to 10 vdc external control signal for speed control.

.10 Able to accept a remote start / stop control.

.11 Minimum of three programmable preset speeds to facilitate operation of the unit from interlocks, at fixed speeds.

.15 Provide EMI filters to reduce EMI to FCC acceptance levels.

.16 The units shall have the following components:

.1 Run and Stop pushbuttons or switch.

.2 Hand-Off-Auto selector switch.

.3 Manual speed adjusting potentiometer.

.4 Fused disconnect switch rated for the full connected load and complete with lockable, through door operator, defeatable with screwdriver. Fuses to be suitable semi-conductor rated.

.5 Trip relay with light.

.6 Run relay with light.

.7 Analogue speed indicator, 0 - 110%, 50mm [2"] bezel minimum.

.8 110 volt control transformer, fused in the primary and secondary.

.9 Auto reset thermal overload - relay interlocked in run circuit.

.10 Terminal strip to accept N.C. safety contacts such as freeze stats and smoke alarms to safety shut down VSD when in Hand or Auto position.

.11 N2 Interface card for interface with BMS to provide full control, status and alarm interface.

.12 Form C contacts to indicate run mode.

.13 Form C contacts to indicate fault or alarm mode.

.14 0 to 10 vdc output signal directly proportional to controller's speed.

.15 Provide integral factory wired and mounted bypass provisions, where scheduled, such that the controlled motors can be manually put into operation bypassing the VSD.

Bypass to consist of a motor contactor and overload relay rated for the connected load. The bypass must have its own isolating device to allow corrective work on the VSD whilst operating in the bypass mode. Bypass contactor and VSD must be fully interlocked to prevent both outputs being enabled simultaneously. Control of the bypass will be by means of an enclosure door mounted VSD Bypass selector and Start Stop pushbuttons. Two door mounted lamps shall be provided to indicate operating mode (VSD or Bypass).

.17 Units shall be equipped with a 5% line reactor and a harmonic filter on the power input side to prevent the backfeeding of harmonics into the power system. Filters should control the THD within the values specified by IEEE 519.

.18 VSD's shall be installed by the Controls Contractor. All power wiring connections shall be by Division 16 and all control wiring by the Controls Contractor.

.19 The manufacture's representative shall be present at start-up and shall supervise the start-up and test the voltage at the motor connection with the Commissioning Agency present with a digital oscilloscope with storage capacity and with a sufficiently fast sample time to accurately measure voltage rate of rise to confirm that the voltage spikes and rate of rise are within the specified level. Submit the results to the Engineer including the input voltage on all three phases to the VSD at the time of measurement.

.20 The manufacturer's representative shall be present for a minimum of 1/2 day to instruct the building maintenance personnel in the correct use and operation of the VSD units following the commissioning of the systems.

.21 Provide a parts and labour warranty for three years subsequent to Substantial Completion for the Variable Speed Drives.

.22 Provide a three year parts and labour warranty against VSD related failure for each motor connected to a VSD power output.

.23 Shop drawings shall include:

.1 Dimensional drawings.

.2 All connection points.

.3 Power circuit diagrams.

.4 Installation and maintenance manuals.

.5 Warranty description.

.6 Certification of agency approvals.

.7 Conformance to each specified requirement.

.8 Placement of input and output reactors / filters, EMI filters, semi-conductor rated fuses (where required).

.9 Harmonic analysis indicating the level of harmonic distortion that the drives will cause.

.24 Variable speed drives shall be configured with hand-off-auto override capability. For applicable fans, the hand position shall override the normal EMCS control output but not the FFPC control output or the freeze protection interlock. When the VSD is bypassed for maintenance or due to failure the controlled motor shall operate as if in hand position such that the FFPC control output and the freeze protection interlock (if applicable) are not overridden.

.25 Standard of Acceptance: ABB, Allen-Bradley, Baldor, Hitachi, Graham, Siemens, Teco- Westinghouse, Toshiba, or equivalent.

Part 3 Execution

3.1 GENERAL

.1 Coordinate and interface with existing “Reliable” Building Automation System.

.2 All equipment shall be installed according to manufacturers' published instructions.

.3 Temperature and Thermostats:

.1 All sensors shall be stabilized to such a level as to permit on-the-job installations that will require minimum field adjustments or calibration.

.2 Sensor assemblies shall be readily accessible and adaptable to each type of application in such a manner as to allow for quick, easy replacement and servicing without special tools or skills.

.3 Outdoor installation shall be weatherproof construction in NEMA 4 enclosures. Install space instruments at a height of 1.5 m above the finished floor, unless otherwise indicated.

.4 Install corridor instruments at a height of 2.1 m above the finished floor.

.5 Locate instruments in the same vertical centreline as light switches.

.6 Where instruments are indicated on an outside wall install on a stand-off wall bracket which provides an air space between the instrument and the wall; or on an insulating base (e.g. a cork pad).

.7 Install protective metal guards on instruments in areas where they may be subject to damage (loading areas, inmate areas, common dining, secured areas, public corridors and storage areas). Bolt

guards, independent of instruments to separate baseplates. Provide backing in wall for securing mounting bases. Coordinate with Departmental Representative for all exposed sensors for protective guard requirements.

.8 Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only, and shall not be located in dead air spaces. The location shall be within the vibration and velocity limits of the sensor. Where an extended surface element is required to properly sense the average temperature it shall be securely mounted within the duct to measure the best average temperatures. Elements shall be thermally isolated from brackets and supports to respond to air temperature only. Sensor element to be supported separately and not connected to coils or filter racks.

.9 Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well. Well shall not restrict flow area to less than 70 percent of line-size-pipe normal flow area.

.4 Temperature Transmitters, Current to Pneumatic Transducers, Solenoid Air Valves, Controllers and relays to be installed in NEMA I enclosures.

.1 Panels to be either free standing or wall mounted ANSI 61 polyester powder coated steel cabinets with hinged and key locked front door. Arrange for conduit and tubing entry from top, bottom or either side.

.2 Panels shall be modular multiple panels being used if required for capacity in any particular location.

.3 All panels shall be lockable with same key.

.4 All wiring within panels to be located in trays or individually clipped to back of panel, and clearly identified.

.5 All field devices to be properly identified.

.6 Mount electrical instruments on standard electrical rough-in boxes fastened to structure.

.7 Testing:

.1 All field devices shall be properly calibrated and tested for performance and accuracy. A report detailing test performed and results to be submitted to the Departmental Representative for approval. The Departmental Representative will verify results at random. Provide all testing equipment necessary. Provide manpower necessary to assist Departmental Representative's verification.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

.2 Coordinate and interface with existing "Delta" Building Automation System.

.3 Exiting Facility (building control contractor) is to be engaged only for the work that is necessary to be done for final integration.

1.2 SCOPE OF WORK

.1 Install new DDC network (BACnet open protocol) in "new 96 cells maximum security building" (complete with OWS in this building), and integrate this network, including DDC network serving "existing 96 cells maximum security building" with "existing facility network".

.2 Coordinate with Departmental Representative for minimum general requirements meeting their standards in addition to those listed below.

1.3 GENERAL REQUIREMENTS

.1 Performance requirements of the Building Automation System (BAS) and associated hardware and software are specified in this section and defines the minimum hardware and performance requirements.

.2 The BAS system shall be a real-time, online, multitasking, multi-user, micro processor based system.

.3 All of the specified programming features must be written by the controls contractor and available for use by the Departmental Representative. These features will all be tested and verified during commissioning. It shall not be satisfactory to merely provide software that is capable of these features if programmed by the Departmental Representative.

.4 Environmental Conditions: The BAS and its immediate associated devices shall be able to operate properly under environmental conditions of 0 deg.C. to 44 deg.C. and a relative humidity of 10 to 95 percent noncondensing.

1.4 RADIO FREQUENCY INTERFERENCE (R.F.I.)

.1 Ensure that all equipment installed under this division is capable of operating properly when subjected to the ambient radio frequency signals existing at the site and in accordance with the Radio Interference Regulations (RIR).

.2 Take into consideration all A.M., F.M., T.V., U.H.F. and V.H.F. signals generated by private and commercial transmitters as well as spurious signals generated by facility equipment.

.3 Provide traps as required to reduce all radio frequency and electromagnetic interference signals to acceptable levels.

1.5 SOFTWARE UPDATE

.1 Patches to the software package shall be provided at no cost for the life time of the system. These shall include all patches and fixes to the original software package supplied, but shall not necessarily include new software products subsequently released by the manufacturer after substantial completion.

1.6 SPARE PARTS

.1 Provide written assurance that in the event of a catastrophic failure of the system or portion thereof, the manufacturer or the system sub-contractor is able to obtain components for replacement with a maximum turn-around of 24 hours.

Part 2 Products

2.1 GENERAL PRODUCT DESCRIPTION

.1 The Building Management System (BMS) shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.

.2 The Building Management System shall consist of the following:

.1 Standalone Panels (SAPs).

.2 Terminal Unit Controllers (TUCs).

.3 Portable Operator's Terminals (POTs).

.4 Personal Computer Operator Work Station(s) (OWSs).

.3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, SAPs, applicable TUCs and operator devices.

.4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each SAP shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

.5 SAPs shall be able to access any data from, or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. SAPs shall also be able to send alarm reports to multiple operator work stations without dependence upon a central processing device.

.6 The Building Management System shall be capable of accepting Autocad drawing files. The Autocad drawings shall be interfacial with the control system graphics software via stripped down DWG files, which are converted into Windows Metafiles for use as graphics for BMS.

2.2 NETWORKING/COMMUNICATIONS

.1 Networking/Communications capabilities shall consist of:

.1 Peer to Peer Communications between SAPs.

.2 Operator Work Station Interconnection.

.3 Terminal Unit Controller (TUC) communications.

.4 Off-site modem communications.

.2 Peer to Peer Interpanel Communications:

.1 SAPs shall communicate with one another over a high speed peer to peer protocol communications bus. All devices on the bus shall be peers and no specific device shall be designated as the master for communications purposes. The failure of any one device on the peer bus shall not result in a loss of communications between any of the other devices on the bus.

.2 Communication protocol shall employ token passing or collision detection to manage access to the bus in a peer to peer fashion. Minimum baud rate shall be 38.4K and system throughout capability shall be sufficient to satisfy the requirements in Section 2.3.2.

.3 The system shall have the ability to establish priority levels in terms of accessing the peer bus. The peer protocol shall be able to distinguish between alarms, automatic data transfer, manual commands and database transfers and the relative priorities between these events shall determine their access to the bus and consequently the relative speeds of these transactions.

.3 Operator Work Station Interconnection:

.1 Operator work stations shall access the peer bus by either directly connection to a SAP via an RS232 port or directly to the peer bus. If directly connected, it shall be via a device that resides on the bus as a true peer with only one OWS per such device.

.2 The systems shall support multiple OWSs connected to the peer bus either through multiple SAPs or multiple peer devices or a combination of both. When changes are made to datafiles at one OWS (including but not limited to graphics files, graphics link files, point datafiles, point labels and panel datafiles), they shall be automatically updated at all other OWSs (except those that are off-site). This shall be accomplished directly over the peer bus or via a parallel Local Area Network (LAN).

.4 Terminal Unit Controller (TUC) Communications:

.1 TUCs shall communicate with one another and a higher order device on the peer bus via a communications bus with a minimum 9600 baud rate. The TUC communications bus shall access the main peer bus via an SAP or a node device that acts as a full peer on the main bus.

.2 The TUC communication protocol shall be either poll / response (with the peer device acting as the master) or peer to peer.

.5 Off-Site Modem Communications:

.1 Each SAP shall support a dial in / dial out modem for connection of an offsite OWS.

.2 SAP shall be able to automatically dial out to a user definable number upon the occurrence of any programmable event or alarm occurrence.

.3 The system shall support dialing in from an off-site OWS which will have all of the capabilities specified for a directly connected OWS. Provide hardware and software for OWS in "central maintenance operating department" with all capabilities as directly connect OWS. Allow for new OWS, if necessary in central maintenance operating building.

.4 The system for this project shall be provided complete with one autodial modem connected to one of the SAPs.

2.3 PROCESSING SPEED

.1 Effective Panel Processing Speed (All Panels):

.1 The maximum permissible execution time is TWO (2) seconds and is defined as follows:

.1 Execution Time:

.1 The time required for the CPU in the stand-alone panel to execute all application software in the panel, from the same point in the software back to the same point, assuming full memory usage as defined in 1.3, while simultaneously responding to operator or terminal display requests and carrying on normal inter-panel communications averaged over a ONE (1) minute period.

.2 The execution time will be verified by setting up a counter in each panel and monitoring the counting rate.

.3 Provide with the proposal the estimated execution time for each panel in the system as configured to this job.

.2 Effective System Processing Speed:

.1 The effective system processing speed applies to multi-panel systems only. The system processing speed is intended to address inter-panel communications and will be monitored by evaluating the delays in inter-panel data transfer.

.2 The effective system processing speed will be verified by initiating a cyclical flag in one panel every minute. This flag will initiate a counter and at the same time command a flag in a remote panel. The remote flag will be used to terminate the counter in the original panel. The value of the counter will be compared to a continuous counter over a one hour period to determine the average delay in inter-panel data transfer. The test will be carried out with the system fully commissioned and all memory requirements specified herein invoked.

.3 The maximum allowable delay for data transfer between SAPs shall be 5 seconds for normal data and 1 second for alarms (not including panel cycle times).

.4 If critical alarm generating points are connected to TUCs then the maximum delays for getting the information to the applicable SAP shall be as per 2.3.2.3 above.

.5 The maximum delay between an alarm event in a SAP or TUC and having that alarm annunciated to the OWS(s) shall be four (4) seconds including panel cycle time. This will be verified with the system fully loaded and commissioned.

2.4 STANDALONE PANELS (SAPS)

.1 General: SAPs shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each SAP shall consist of all required hardware including but not limited to processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

.2 Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:

.1 Control processes

.2 Energy Management Applications

.3 Alarm Management

.4 Historical/Trend Data for all points

.5 Maintenance Support Applications

.6 Custom Processes

.7 Operator I/O

.8 Dial-Up Communications

.9 In addition to the memory required to accommodate all of the points and sequences specified, each SAP shall have memory capacity to accommodate trending of all inputs and outputs with 100 samples per point. This shall include all points connected to subordinate TUCs if they do not have their own on-board trending capabilities.

.3 Point Types: Each DDC panel shall support the following types of point inputs and outputs if applicable:

.1 Analog inputs:

.1 4 - 20 Milliamps

.2 0 - 10 Volts DC

.3 120 Volts AC

.4 10,000 ohm thermistor

.5 100,000 ohm thermistor

.6 100 or 1000 ohm Pt

.7 1000 ohm Ni

.8 20.7 - 103.4 kPa [3 - 15 psi] (via external transducer)

.2 Digital inputs:

.1 Dry contact closure

.2 Pulse accumulator (i.e. electrical consumption)

.3 Actuators/Output Signals:

.1 Digital outputs (contact closure):

.1 Motor starters, sizes 1 to 4 (via external relays)

.2 Analog outputs:

.1 4 - 20 Milliamps

.2 0 - 10 Volts DC

.3 Triac 24 Volts AC

.4 20.7 - 103.4 kPa [3 - 15 psi] (via external transducer).

.4 The DDC panel electronics shall be housed in a metal cabinet with keylock utilizing a master key.

.5 Spare Points: The system shall have spare points capacity for future use. Housed in one specific DDC panel in each mechanical room the spares shall be comprised of not less than six analog and ten digital inputs as well as six analog and ten digital outputs. These shall not require any vendor specific hardware or software to utilize.

.6 Expandability: The system architecture shall support a future system capacity of 5000 control points including points connected to SAPs and TUCs.

.7 Serial Communication Ports: SAPs shall provide at least two (2) serial data communication ports in addition to the network communication port, for simultaneous operation of multiple operator I/O devices such as industry standard printers, OWSs and Portable Operator's Terminals. SAPs shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.

.8 Hardware Override Switches: The operator shall have the ability to manually override automatic or centrally executed commands at the SAP via local, point discrete, onboard hand/off/auto operator override switches for binary control points and analog control type points.

.9 Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self- diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication.

.10 Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as line voltage wiring where acceptable by electrical code.

.11 Powerfail Restart:

.1 In the event of the loss of normal power, there shall be an orderly shutdown of all SAPs to prevent the loss of database or operating system software. Non-Volatile memory (EPROM, EEPROM or FLASH RAM) shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

.2 Provide automatic power failure routine to accomplish orderly shutdown of the automation system when loss of power is detected. Do not place any equipment in an unacceptable or dangerous condition as a result of power failure or restart procedures.

.3 Restart the system automatically and in an orderly fashion upon power restoral.

.4 Restart equipment based on priority to minimize in-rush currents as large loads are reintroduced.

.5 Restart only those systems or loads which were operating at the time of shutdown.

.6 Alarm any equipment which fails to restart when requested.

.7 Provide manual restart lockout capability.

.12 Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

.13 Should SAP memory be lost for any reason, the system shall generate an alarm. The user shall have the capability of reloading the SAP via an OWS which is either on-site or via modem.

2.5 SYSTEM SOFTWARE FEATURES

.1 General:

.1 All necessary software to form a complete operating system as described in this specification shall be provided. The software shall become the property of the Departmental Representative, who shall have full control over its use (within the confines of the Project). Provide the user with all necessary access codes to all levels of software programming and control system access including custom DDC programming. The quoted cost shall include for all necessary licensing, fees, cost, agreement requirements etc. so that the Departmental Representative has unrestricted use of the software.

.2 The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

.2 Control Software Description:

.1 Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:

.1 Two Position Control.

.2 Proportional, Integral, plus Derivative Control.

.3 Floating three position control (where specified).

.2 Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

.3 Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.4 Powerfail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

.3 Energy Management Applications: SAPs shall have the ability to perform any or all of the following energy management routines:

.1 Time of Day Scheduling

.2 Calendar Based Scheduling

.3 Holiday Scheduling

.4 Temporary Schedule Overrides

.5 Optimal Start

.6 Optimal Stop

.7 Night Setback Control

.8 Enthalpy Switchover (Economizer)

.9 Peak Demand Limiting

.10 Temperature Compensated Load Rolling

.11 Fan Speed/CFM Control

.12 Heating/Cooling Interlock

.13 Supply Air Reset

.14 Hot Water Reset

.15 All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

.4 Custom Process Programming Capability: SAPs shall be able to execute custom, job- specific processes defined by the user, to automatically perform calculations and special control routines.

.1 Process Inputs and Variables: It shall be possible to use any of the following in a custom process:

.1 Any system-measured point data or status

.2 Any calculated data

.3 Any results from other processes

.4 User-Defined Constants

.5 Arithmetic functions (+,-,*,/, square root, exp, etc.)

.6 Boolean logic operators (and, or, exclusive or, etc.)

.7 On-delay/Off-delay/One-shot timers

.2 Process Triggers: Custom processes may be triggered based on any combination of the following:

.1 Time interval

.2 Time of day

.3 Date

.4 Other processes

.5 Time programming

.6 Events (e.g., point alarms)

.3 Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other panels on the system including SAPs and TUCs

.1 In addition, a single process shall be able to issue commands to points in any and all other panels on the system including SAPs and TUCs.

.4 Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow- up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

.5 All SAPs must be fully user custom programmable. Application specific controllers will not be accepted except for TUC applications as noted in the points list.

.5 Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. SAP shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non- critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Work station or local I/O device, or communications with other panels on the network.

.1 Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

.2 Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

.3 Report Routing: Alarm reports, messages, and files will be directed to a user- defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

.4 Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 50-character alarm message to more fully describe the alarm condition or direct operator response. Each SAP shall be capable of storing a library of at least 250 Alarm Messages.

.5 Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

.6 Historical Data and Trend Analysis: Trend analysis shall be time event and/or deviation based and must be capable of graphing at least 8 separate trends simultaneously. A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

.1 Continuous Point Histories: SAPs shall store Point History Files for all analog and binary inputs and outputs (minimum of 100 samples per point).

.2 Dynamic Control Loop Performance Trends: SAPs shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds for verification of control loop performance.

.3 Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-defineable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours shall be provided. Each SAP shall have a dedicated buffer or capability of

down loading to an on-line data storage and retrieval computer for trend data, and shall be capable of storing a minimum of 5000 data samples.

.4 Data Storage and Archiving: Trend data shall be stored at the SAPs, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party personal computer applications.

.7 Runtime Totalization: SAPs shall have the ability to accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

.1 The Totalization routine shall have a sampling resolution of one minute or less.

.2 The user shall have the ability to define a warning limit for Runtime Totalization.

.3 Unique, user-specified messages shall be generated when the limit is reached.

.8 Analog/Pulse Totalization: SAPs shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

.1 Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, litres, KBTU, tons. etc.).

.2 The Totalization routine shall have a sampling resolution of one minute or less.

.3 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

.9 Event Totalization: SAPs shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

.1 The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

.2 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.6 TERMINAL UNIT CONTROLLERS (TUCS)

.1 Terminal Unit Controllers (TUCs) shall be used to control terminal equipment and other miscellaneous points as noted on the points list.

.2 Each TUC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each TUC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

.3 Each TUC shall have sufficient memory to support its own operating system and data bases including:

.1 Control Processes

.2 Energy Management Applications

.3 Portable Operators Terminal (POT)

.4 The operator interface to any TUC point data or programs shall be through any OWS or any POT connected to any SAP or TUC in the network.

.5 TUCs shall directly support the temporary use of a POT. The capabilities of the portable operators terminal shall include, at minimum, the following:

.1 Display temperatures

.2 Display status

.3 Display set-points

.4 Display control parameters

.5 Override binary output control

.6 Override analog set-points

.7 Modification of gain and offset constants

.8 Program parameter adjustments

.9 Trend log displays edit/create trend logs

.10 Display/Command any point connected to any TUC or SAP in the system.

.6 Powerfail Protection: All system set-points, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller. TUCs shall employ EEPROM or FLASH RAM for this functionality.

.7 Application Descriptions:

.1 VAV Reheat Coils, CV Reheat Coils, Perimeter Radiation controls only. Terminal Unit Controllers shall support, but not be limited to, the control of the terminal units to address current requirements as described in the Execution portion and points list of this specification.

.2 It is anticipated that TUCs will be application specific and thus not custom user programmable. The application software provided with the TUCs shall meet the requirements of the sequences of operation as specified herein and the programming and potential subsequent reprogramming of the TUCs shall be subject to clause 1.2.4 in Section 15910.

.3 For TUCs used in VAV applications, they shall have a built-in solid state flow transmitter for sensing air flow. Heated wire flow sensors will not be acceptable. It shall be the responsibility of this contractor to ensure that the flow transmitter is compatible with the velocity pressure probe supplied with the VAV box.

2.7 OPERATOR INTERFACE

.1 Basic Interface Description

.1 Command Entry/Menu Selection Process: Operator Work station interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change set-points from graphical displays through the use of a mouse or similar pointing device.

.2 Graphical and Text-Based Displays: At the option of the user, Operator Work stations shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all work stations.

.3 Multiple, Concurrent Displays: The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow

the user to analyze system performance. If the interface is unable to display several different types of displays at the same time, the controls contractor shall provide at least two operator stations.

.4 Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit work station control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

.1 Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.

.2 A minimum of four levels of access shall be supported.

.3 A minimum of 50 passwords shall be supported at each DDC panel.

.4 Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log- on.

.5 User-defineable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on- line.

.6 It shall be possible to limit which points in the system that a particular operator has access to.

.5 Operator Commands: The operator interface shall allow the operator to perform all commands required to operate or program the entire system.

.6 Logs and Summaries: Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:

.1 A general listing of all points in the network.

.2 Individual lists of all points currently in alarm, off-line, in override status, disabled, or locked out.

.3 List all Weekly Schedules.

.4 List all Holiday Programming.

.5 List of Limits and Deadbands.

.6 Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

.7 Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and boiler systems, shall be provided as specified herein to optimize system performance analysis and speed alarm recognition.

.1 System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.

.2 Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

.3 Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

.1 Libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols shall be provided.

.2 The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

.1 Define symbols

.2 Position and size symbols

.3 Define background screens

.4 Define connecting lines and curves

.5 Locate, orient and size descriptive text

.6 Define and display colors for all elements

.7 Establish correlation between symbols or text and associated system points or other displays.

.3 Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including Terminal Unit Controllers used for DDC unitary or VAV terminal unit control.

.4 Pre-Constructed Graphics

.1 Provide a complete set of pre-constructed graphics for use with the system at time of hand-over.

.2 Provide, at minimum the following dynamic graphics.

- All supply air systems.
- All return air systems.
- All exhaust air systems.
- All air handling ventilation units.
- Hot water heating system.
- Domestic hot water heating systems.
- Heat recovery systems. (Heat Pump)
- Fire alarm zones for each floor or fire zone. Refer to description of FFPC system.
- Smoke evacuation system.
- Chilled water system.
- Make-up air system.

.8 System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

.1 The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

.1 Add/Delete/Modify SAPs, Modify Operator Work stations, TUCs.

.2 Add/Delete/Modify points of any type, and all associated control loops, point parameters, and tuning constants.

.3 Add/Delete/Modify Totalization, Historical Data Trending for every point.

.4 Add/Delete/Modify custom control processes and all graphic displays, symbols, and cross-references to point data.

.5 Add/Delete/Modify dial-up telecommunication definition, operator passwords and Alarm Messages.

.2 System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.

.3 Database Save/Restore/Back-Up: Back-up copies of all standalone panel databases shall be stored in at least one personal computer operator work station. Continuous supervision of the integrity of all SAP data bases shall be provided. In the event that any SAP on the peer bus experiences a loss of its data base for any reason, the system shall automatically download a new copy of the respective data base to restore proper operation. Data base back-up / download shall occur over the peer bus without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of a SAP data base.

.9 Personal Computer Operator Work station Description:

.1 Primary and Secondary Personal Computer Operator Work Station shall be provided for command entry, information management, network alarm management, and database management functions. All real-time control functions shall be resident in the SAPs to facilitate greater fault tolerance and reliability.

.1 Provide working station (PC) compatible with the latest windows separating environment, with adequate “hard drive” storage, RAM, 22” monitor, Ethernet card, etc.

.2 The primary Operator Work Station shall be located in the Mechanical Room or Facilities Operator’s Office. (Confirm exact location with the Departmental Representative and Facilities Operation). Provide control over the complete communication system and monitor all connected SAPs throughout the system for change-of-state, change-of-value, or no response conditions. Centrally resident software shall be provided for the operator interface, temporary scheduling, control of holiday programming, definition process programming, automatic initialization routines, real-time logs, historical storage, reporting, trend logging and full on-line dynamic graphics.

.3 Secondary OWS Shall be installed in “Central Maintenance Department Building” with all capabilities of Primary OWS. This secondary OWS is to have full access and control of new maximum security pods and buildings, as well of recently upgraded building. (Access to all buildings required via secondary OWS.) Exact location of secondary OWS is to be coordinated with (Michael Cuccione, Phone: 604-796-3127, PWGSC).

END OF SECTION

1.1 General

.1 The control system for the facility is connected with and integrated with.

.2 General control for the facility is not changed. This control sequence addresses only the components adjusted and modified as part of the DHW upgrade project.

.3 Control sequence is to be read in coordination with the existing controls.

1.2 Air Handling Unit #3 (Administration Area) – No change

.1 AHU-03 operates in occupied / unoccupied cycles as programmed by DDC system.

.2 In the occupied mode, the supply fan is started. The return fan starts at the same time,(software interlock with supply fan). Status of both fans is to be monitored by current sensors. Should either fan not match its commanded state an alarm shall be generated at the building operation computer.

.3 The supply air temperature (SAT) set point is to be 18ºC when room (the warmest room/zone) temperature is 2ºC lower than room temperature set point , and SAT set point is to be 12ºC when room temperature is 2ºC higher than room temperature set point for the same room as described above.

.4 When the outdoor air temperature is below 18ºC, the mixed air damper, relief damper, outdoor air damper and heating valve will be modulated/staged as necessary to maintain SAT set point. On call for free cooling the outdoor air damper and relief damper will open as return air damper closes. On call for heating, first dampers are modulated back to their minimum position, (a fixed value will be set by balancing contractor) then the heating valve is opened to add heat as required.

.5 A mixed air low limit calculation is to override the minimum damper position and force the outdoor air damper to close/return open as the mixed air temperature drops below 10ºC, modulating fully closed as the temperature reaches 6ºC.

.6 Zone reheat coils (located in supply ductwork) with their respective two way modulating valves are to provide any additional necessary heat balance, in order to maintain desired room temperature set point.

.7 When outdoor air temperature is above 18ºC, mixed air damper is to return into minimum position and heating valve is to be closed. The average of the 5 warmest room temperatures will be used as indication of need for potential cooling. When this calculated average temperature is 22.5ºC, system shall start opening cooling control valve and modulate it as necessary to maintain desired calculated average rooms temperature set point of 22ºC.

.8 In unoccupied mode, the fans are shut down. Should the lowest zone temperature drop below 16ºC, the fans will be restarted and the system will run as in the occupied mode.
Only the reheat for zone that activated night set back will open. The supply air will remain at the 18ºC. Dampers are to remain in full recirculation position.

.9 The static pressure differential across the filters is to be monitored via pressure switch for alarm purposes. Indicated alarm on operating computer station when pressure exceeds 250Pa (adjustable).

.10 On detecting a temperature of 4ºC or less anywhere along the length of the sensor, freezstat will trip and shut down supply fan. Status of freezstat is monitored thru the DDC and it will shut down the return fan. An alarm will be generated at the building operation computer. A manual reset is required at the device to restart the system.

.11 When the fans are off, the outdoor air damper and relief damper will close, return air damper will open. The cooling control valve will be closed. The heating valve will modulate as necessary to maintain minimum AHU-03 supply plenum temperature of 10ºC.

.12 Additional local HOA switches are to be installed in "Control Post" for manual control of AHU-03 interlocked with respective dampers as necessary. (Coordinate with Electrical Trade). All HOA switches to be complete with LED indicators.

1.3 Air Handling Unit #5 (Command Post) – No Change

.1 AHU-5 operates in an occupied/unoccupied cycled as programmed by the DDC system.

.2 In the occupied mode, the supply fan is started. The status of the fan is monitored by a current sensor. Should the fan not match its commanded state an alarm will be generated at the building operation computer.

.3 The supply air temperature set point will be determined to maintain the warmest zone to set point according to the following schedule:

Warmest Zone Temp	Supply Set Pont
-2ºC below Set Point	18ºC
+2ºC above Set Point	12ºC

.4 When the outdoor air temperature is below 18ºC, the mixed air damper and heating valve will be modulated in series to maintain the supply temperature to the calculated set point. On a call for heating, first the dampers are modulated back to their minimum position, (a fixed valve set by the air balancing contractor) the heating valve is opened to add heat as required.

.5 A mixed air low limit calculation will override the minimum damper position and force the outdoor air damper close/return open as the mixed air temperature drops below 10oC modulating fully closed as the temperature reaches 6°C

.6 Reheat coils in the supply ductwork to each zone will heat the balance of zones to their room temperature set point.

.7 When outdoor air temperature is above 18ºC, mixed air damper is to return into minimum position and heating valve is to be closed. The average of the 2 the warmest room temperatures will be used as indication of need for potential cooling. When this calculated average temperature is 22.5ºC, system shall start opening cooling control valve and modulate it as necessary to maintain desired calculated average rooms temperature set point of 22ºC.

.8 In the unoccupied mode, the fan is shut down. Should the lowest zone temperature drop below 16°C, the fan will be restarted and the system will run as in the occupied mode.
Only the reheat for zones that activated the night set back will open. The supply air will remain at 18°C. The dampers will remain in the full recirculation position.

.9 The static pressure differential across the filters is to be monitored via pressure switch for alarm purposes. Indicated alarm on operating computer station when pressure exceeds 250Pa (adjustable).

.10 On detecting a temperature of 4ºC or less anywhere along the length of the sensor, freeze-stat will trip and shut down supply fan. Status of freeze-stat is monitored thru the DDC and it will shut down the return fan. An alarm will be generated at the building operation computer. A manual reset is required at the device to restart the system.

.11 When the fan is off, the outdoor air damper and relief damper will close, return air damper will open. The cooling coil control valve will be closed. The heating valve will modulate as necessary to maintain minimum AHU-05 supply plenum temperature of 10ºC.

.12 Additional local HOA switches are to be installed in "Control Post" for manual control of AHU-05 interlocked with respective dampers as necessary. (Coordinate with Electrical Trade). All HOA switches to be complete with LED indicators.

1.4 FCU-01 & FCU-02 (serving rooms #2802 and 2803)

.1 Fan coil units maintain essentially the same function, except that they are cooled by an independent (DX) system instead of the chilled water.

.2 Both units FCU-01 & 02 work in duty/standby configuration.

.3 This system is to run on continuous basis, controlled through DDC. Interface also with the communication kit (provided with the condensing unit).

.4 Each unit fan is to start upon end switch proof on dedicated isolation damper.

.5 Status of each unit running is to be monitored through DDC.

.6 Condensing units are cycled and modulated as necessary, to maintain average calculated room temperature set point of 25 ºC (for the two (2) rooms served) - set point adjustable. Interface with condensing unit controller.

.7 When each of these units is not in its scheduled operating mode, its associated motorized isolation damper closes.

.8 In case of unit failure during operation, other (standby) unit starts.

1.5 FCU-03 & FCU-04 (serving rooms #2800 and 2801)

.1 Fan coil units maintain essentially the same function, except that they are cooled by an independent (DX) system instead of the chilled water.

.2 Both units FCU-03 & 04 are dedicated to serve their independent respective zone.

.3 Each FCU system is to run on continuous basis, controlled thru DDC. Interface also with the communication kit (provided with the condensing unit).

.4 Status of each unit running is to be monitored thru DDC, by current sensor.

.5 Each unit fan is to start upon end switch proof on dedicated isolation damper.

.6 Condensing units are cycled and modulated as necessary, to maintain room temperature set point for each of the two (2) rooms served) – room temperature set point of 22ºC is adjustable for each room. Interface with condensing unit controller.

.7 In case of any of the unit failure during operation, isolation damper MD-25 opens, allowing for single unit to provide partial cooling to both zones/rooms (#2800 and #2801).

1.6 Heating Hot Water Boiler Loop (Primary loop)

.1 Both boilers and their respective inline circulators shall work in lead/lag fashion. Should the lead boiler or its pump fail, the lag boiler and its respective inline pump will be started in its place.

.2 When secondary heating loop (see following section, “Heating Hot water system (secondary loop)”)) is in operation, as result of heat demand call in building heating system, primary heating water loop (boiler loop) will operate as necessary in order to maintain secondary heating water loop desired hot water supply set point.

.3 Proof of inline circulator/pump flow from the flow switch is required for the lead boiler to be enabled.

.4 The boiler supply water set point is adjusted linearly between schedule limits in accordance with secondary heating water loop, hot water supply temperature schedule.(see following section “Heating Hot water system (secondary loop)”).

.5 Boilers control to supply water temperature and buffer tank temperature.

.6 Adjust cycling at low partial load conditions.

1.7 Heating Hot Water System (Secondary Loop)

.1 Either pump P1-HW or P2-HW will start on a heating demand call from the Domestic Hot Water heaters/tanks, AHU-1, 3, 4, 5, or from the in slab heating system.

.2 The pumps will operate in a lead/lag fashion. Should the lead pump fail (proven by either flow switch or current sensors/pump status), the lag pump will be started in its place.

.3 Pumps are VFD controlled. The pressure differential transmitter (location selected by Control contractor) is to be monitored and speed of the pump is to be adjusted to maintain the pressure differential at some fixed set point (set point balancing and control contractor defined during commissioning stage). Pressure differential set point is to be DDC reset as necessary, based on monitoring control valves position, ensuring that at least one valve is 90% open still satisfying space set point.

.4 Modulate control valve CV-01 (located at the end of the hot water system mains (see schematic drawing), as necessary when minimum load occurs and minimum pump flow and system head is to be maintained for valves controllability.

.5 The heating hot water system (secondary loop) supply water set point is adjusted linearly between schedule limits according to the following schedule.

Outdoor Air Temperature	Supply Water Temperature
-10°C or less	82°C
10°C or more	70°C

.6 When there is no longer any heating call from the system, the lead pump will also be disabled.

1.8 Domestic Hot Water

.1 Domestic hot water system is re-piped (and set) to have two domestic hot water tanks DHWT-01 and DHWT-02 operate in parallel.

.2 Domestic hot water supply temperature, as well as the tank storage temperature, shall be adjusted to maintain return water temperature in recirculation line at 60°C.

.3 New heat exchangers: Modulate two way control valve as necessary to achieve average tank water temperature of 60°C to 62.8°C (set-points adjustable). Once the high temperature set-point (of 62.8°C – adjustable) inside tank is reached close the control valve. Heating valve is to stay closed until tank average temperature drops to 60°C (adjustable). Upon tank water temperature reaching 60°C (adjustable), valve shall open and start modulating again, as necessary to bring tank temperature back to setpoint (60°C to 62.8°C - set-points adjustable).
(Note: Existing immersion heaters will be removed).

.4 Should the average tank temperature exceed 65°C, an alarm is to be generated at the building operation computer.

.5 DDC is to monitor both, tanks temperatures (high and low tank levels), and re-circulation pump status.

1.9 Chiller (CH-1) System

.1 General:

.1 Major Components:

.1 Modular packaged chiller

.2 Chilled water pumps P1-CHW and P2-CHW (serve cooling loop) - (pumps sized for 50% load and minimum chiller flow).

.2 Chiller replaces heat recovery heat pumps. Chillers serve cooling only for air handling units; they no longer serve the fan coils, and the heat recovery is no longer available.

.3 Interface with chiller controller (BACnet interface is preferred).

.4 When any chilled water control valve is more than 10% open, the Chiller system shall be operated (chilled water pumps and chiller).

.5 Modular chiller stages in response to the supply water temperature set-point. Stage chilled water pumps as necessary to maintain supply chilled water temperature at 7°C set point. Supply chilled water temperature will be reset from the operation of the air handling unit cooling coils.

.6 The chilled water loop temperature shall be controlled by the chiller control panel, and in response to supply water temperature and chilled water storage tank temperature.

.7 At high or low system loop water temperature and a loss of system water flow, an alarm shall be generated.

.8 The inlet and outlet water temperatures and chilled loop flow shall be monitored and trended.

.9 Chiller operating parameters and alarms shall be monitored on DDC (through BACnet interface).

END OF SECTION

Part 1 **General**

1.1 General

.1 The following points list indicates the input and output points that shall be connected to the B.A.S. Any additional points that are noted in Section 23 09 93 to be under DDC control shall also be included as if they were on the points list. All points associated with one mechanical system shall be connected to the same Stand Alone Panel (SAP). All points shall be connected to SAPs unless they are specifically noted in the points list as TUC points or if the TUC meets the same specifications for user custom programmability as the SAP in Section 23 09 24.

.2 Program alarms as specified in the points list and sequences with user adjustable alarm thresholds. Provide descriptors for all programmed alarms which can be accessed via the graphics at the OWS(s).

1.2 Device Legend

.1 Refer to Section 23 09 13 for specification of devices.

.2 RTS = Room Temperature Sensor

.3 DTS = Duct Temperature Sensor

.4 ITS = Immersion temperature Sensor

.5 ATS = Averaging Duct Temperature Sensor

.6 OTS = Outdoor Temperature Sensor

.7 HS = Humidity Sensor

.8 DPT = Differential Pressure Transmitters

.9 SPT = Static Pressure Transmitter

.10 VPT = Velocity Pressure Transmitter

.11 PSW = Pressure Switch

.12 TSW = Temperature Switch

.13 IPT = Current / Pneumatic Transducer

.14 CR = Current Relay

.15 CS = Current Sensor

.16 EPR = Electric / Pneumatic Relay

.17 FSW = Flow Switch

.18 ESW = End Switch

.19 ER = Electric Relay

.20 DME = Damper Actuator Modulating Electronic

.21 DTE = Damper Actuator Two Position Electronic

.22 DMP = Damper Actuator Modulating Pneumatic

.23 DTP = Damper Actuator Two Position Pneumatic

.24 DMI = Damper Actuator Modulating Incremental Control

.25 VME = Valve Actuator Modulating Electronic

.26 VTE = Valve Actuator Two Position Electronic

.27 VMP = Valve Actuator Modulating Pneumatic

.28 VTP = Valve Actuator Two Position Electronic

.29 VMI = Valve Actuator Modulating Incremental Control

.30 MFT = VAV Box Flow Transmitter

.31 FMS = Electronic Flow Measuring Station

.32 WFS = Water Flow Measuring Station

1.3 Table Legend

.1 **DI** = DIGITAL INPUT; **DO** = DIGITAL OUTPUT; **AI** = ANALOG INPUT;
AO = ANALOG OUTPUT;
X = TUC POINT; **H** = HIGH ALARM; **L** = LOW ALARM; **S** = STATUS ALARM

Part 2 Input / Output Points List

2.1 System: General

		INPUT		OUTPUT				
Unit No.	Point Description	DI	AI	DO	AO	TUC	Alarm	Notes
	Outdoor Air Temperature		DTS					Existing (BAS)

2.2 System: FCU-01 and FCU-02 (Serving Rooms #2802 and 2803)

		INPUT		OUTPUT				
Unit No.	Point Description	DI	AI	DO	AO	TUC	Alarm	Notes
FCU-01	Fan Status		CS					
	Fan Command			ER				
	Cooling Coil TX Valve				X			Interface
	Alarm (status and cooling failure)						X	
	Motorized isolation damper MD-21				DTE			Existing
FCU-02	Fan Status		CS					
	Fan Command			ER				
	Cooling Coil TX Valve				X			Interface
	Alarm (status and cooling failure)						X	
	Motorized isolation damper MD-22				DTE			Existing
CU-01	Start/Stop			X				
	Alarm (status and cooling failure)	X						
	BACnet interface		X		X			
CU-02	Start/Stop			X				
	Alarm (status and cooling failure)	X						
	BACnet interface		X		X			
	Room temperature sensor		RTS					Each Room

Note: Interface with Condensing Unit and Fan Coil Packaged Controller (BACnet connection) and interface with communication kit.

2.3 System: FCU-03 and FCU-04 (Serving Rooms #2800 and 2801)

		INPUT		OUTPUT				
Unit No.	**Point Description**	**DI**	**AI**	**DO**	**AO**	**TUC**	**Alarm**	**Notes**
FCU-03	Fan Status		CS					
	Fan Command			ER				
	Cooling Coil TX Valve				X			Interface
	Alarm (status and cooling failure)						X	
	Motorized isolation damper MD-23				DTE			Existing
FCU-04	Fan Status		CS					
	Fan Command			ER				
	Cooling Coil TX Valve				X			Interface
	Alarm (status and cooling failure)						X	
	Motorized isolation damper MD-24				DTE			Existing
	Motorized isolation damper MD-25				DTE			Existing
CU-01	Start/Stop			X				
	Alarm (status and cooling failure)	X						
	BACnet interface		X		X			
CU-02	Start/Stop			X				
	Alarm (status and cooling failure)	X						
	BACnet interface		X		X			
	Room temperature sensor		RTS					Each Room

Note: Interface with Condensing Unit and Fan Coil Packaged Controller (BACnet connection)

2.4 System: Chiller (Air Cooled) – CH-1

		INPUT		OUTPUT				
Unit No.	Point Description	DI	AI	DO	AO	TUC	Alarm	Notes
CH-1	Chiller Enable/Disable Refrigerant Circuit #1			ER				
	Refrigerant Circuit #1 Status		CS					
	Refrigerant Circuit #1 Alarm/Failure	AUX						
	Chiller Enable/Disable Refrigerant Circuit #2							
	Refrigerant Circuit #2 Status		CS					
	Refrigerant Circuit #2 Alarm/Failure	AUX						
	Chiller Enable/Disable Refrigerant Circuit #3			ER				
	Refrigerant Circuit #3 Status		CS					
	Refrigerant Circuit #3 Alarm/Failure	AUX						
	Chiller Enable/Disable Refrigerant Circuit #4							
	Refrigerant Circuit #4 Status		CS					
	Refrigerant Circuit #4 Alarm/Failure	AUX						
	Chiller chilled water set point				0-10V			
	Chiller status		CS					
	Chiller General Alarm	AUX						
	Chiller chilled water supply		ITS					
	Chiller chilled water return		ITS					
	Chiller chilled water flow switch	FSW						
	Chiller chilled water flow	FMS						
	BACnet interface		X		X			

Notes: Coordinate with Mechanical Contractor/Equipment supplier, Chiller to come with fully compatible BACnet interface.
Interface with BACnet connection

2.5 System: Chilled water hydronic loop

		INPUT		OUTPUT				
Unit No.	Point Description	DI	AI	DO	AO	TUC	Alarm	Notes
	Pump P1-CHW status		CS					Existing
	Pump P1-CHW command			ER				Existing
	Pump P2-CHW status		CS					Existing
	Pump P2-CHW command			ER				Existing
	Chilled water supply temperature (main piping)		ITS					Existing
	Chilled water return temperature (main piping)		ITS					Existing
	Chilled water storage tank high level alarm	PSW						Existing
	Chilled water storage tank low level alarm	PSW						Existing
	Chilled water storage tank high level temperature		ITS					Existing
	Chilled water storage tank low level temperature		ITS					Existing
	Chilled water loop flow status	FSW						Existing

Note: Re-instate existing control points and strategy

2.6 System: Heating Boilers (Primary hot water loop)

		INPUT		OUTPUT				
Unit No.	Point Description	DI	AI	DO	AO	TUC	Alarm	Notes
B-01	Boiler enable/disable	ER						Existing
	Hot water set point				0-10V			Existing
	Entering water temperature		ITS					Existing
	Leaving water temperature		ITS					Existing
	Flow status	FSW						Existing
	Inline Pump status		CS					Existing
	Inline Pump Command	ER						Existing
	Boiler general alarm	AUX						Existing
B-02	Boiler enable/disable	ER						Existing
	Hot water set point				0-10V			Existing
	Entering water temperature		ITS					Existing
	Leaving water temperature		ITS					Existing
	Flow status	FSW						Existing
	Inline Pump status		CS					Existing
	Inline Pump Command	ER						Existing
	Boiler general alarm	AUX						Existing
	Supply water temperature (main)		ITS					Existing
	Return water temperature (main)		ITS					Existing

Note: Coordinate with Mechanical Contractor/Equipment supplier, Boilers to come with fully compatible BACnet interface.
Re-instate existing control points and strategies

2.7 System: Heating water loop (secondary loop)

Note: Coordinate with Mechanical Contractor/Equipment supplier, Boilers to come with fully compatible BACnet interface.
Re-instate existing control points and strategies

2.8 System: DHW Heating

		INPUT		OUTPUT				
Unit No.	Point Description	DI	AI	DO	AO	TUC	Alarm	Notes
	Tank 1 Temperature (high and low level)		ITS				H	Existing
	Tank 2 Temperature (high and low level)		ITS				H	Existing
	Tank 1 Heating Water Valve				VME			Existing
	Tank 2 Heating Water Valve				VME			Existing
	Tank 1 Heat recovery loop EWT		ITS					Existing
	Tank 1 Heat recovery loop LWT		ITS					Existing
HE-1 & HX-2	DHW temperature in		ITS					
	DHW temperature out		ITS				H	
	HW temperature in		ITS					
	HW temperature out		ITS					
CV-DHW1	Control valve (heating side of HX-s)		VME		VME			
CV-DHW2	Control valve (heating side of HX-s)		VME		VME			

END OF SECTION

Part 1 General

1.1 Related Work

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

.2 Refer to Section 23 05 29 and 23 05 49 for required seismic restraint of piping.

1.2 Reference Standards

.1 Do all piping system work in accordance with ANSI/ASME B31.9 code.

1.3 Regulatory Requirements

.1 All components, products and fabrication techniques shall be provided in compliance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

.2 Installation of, and repair or alterations to, pressure piping systems shall be performed only by licensed Contractors and licensed Welders, certified for the work being done in accordance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

.3 All field welding to be in accordance with the procedures of CSA-W117.2 and the current edition of ASME Code for Power Piping and Building Services Piping.

1.4 System Pressure Ratings

.1 Pipe Fittings:

.1 Piping systems 860 kPa [125 psig] or less operating pressure - 860 kPa [125 psig] rating.

.2 Valves:

.1 Suitable for maximum system operating temperature and pressure.

Part 2 Products

2.1 General

.1 All products shall be registered with the regulatory authority in accordance with CSA B51.

.2 There shall be no press-fit or grooved mechanical couplings.

2.2 Pipe

.1 Steel Pipe:

.1 to NPS 10, Schedule 40 to ASTM A53 Grade B.

.2 to NPS 12 and over, 9.5 mm [0.375"] wall thickness to ASTM A53

Grade B.

.3 for the following systems:

.1 Hot water heating

.2 Chemical feed

.3 Relief valve vents

.2 Steel and Stainless Steel Pipe:

.1 to NPS 8, Schedule 80 to ASTM A53 Grade B.

.2 to NPS 10 and over, 12.7 mm [1/2"] wall thickness to ASTM A53 Grade B.

.3 Galvanized Steel Pipe: to ASTM A53, Grade B, galvanized with average coating of 0.55 kg/sq.m. as follows:

.1 Schedule 40 for the following systems:

.1 Pressure drains: NPS 2-1/2 and over.

.3 Copper Pipe: to ASTM B88M-86, Type K, or L hard drawn copper tubing.

.1 Type L, hard drawn:

.1 Pressure drains (to NPS 2).

.2 Type L hard drawn may be used as an alternative to steel piping for the following systems:

.1 Hot water heating.

.3 Type K, hard drawn:

.1 Air vent overflow where exposed.

.4 Type K, soft drawn:

.1 Air vent overflow where concealed.

2.3 Pipe Joints - Steel Piping

.1 NPS 2 and under: screwed fittings, except where otherwise noted, with teflon tape and rectroseal teflon paste or pipe dope.

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W47.1.

.3 Flanges: raised face, steel weld neck, lap or back-welded slip on type. Use flat face for attachment to cast iron valves.

.4 Bolts and Nuts, carbon steel: to ANSI B18.2.1 and ANSI B18.2.2.

.5 Flange gaskets:

.1 Up to 860 kPa [125 psig] system pressure - non-asbestos gaskets for mating surfaces.

2.4 Pipe Fittings - Steel Pipe

.1 Pipe fittings, screwed, flanged or welded:

.1 Cast iron pipe flanges: Class 125 to ANSI B16.1.

.2 Cast iron screwed fittings: Class 125 to ANSI B16.3.

.3 Steel pipe flanges and flanged fittings: to ANSI B16.5.

.4 Steel butt-welding fittings: to ANSI B16.9a.

.5 Unions, malleable iron ground joint type: Class 150 to ANSI B16.3.

2.5 Pipe Joints - Copper Pipe

.1 All sizes, soldered or brazed as specified in EXECUTION.

2.6 Pipe Fittings - Copper Pipe

.1 Cast bronze: to ANSI B16.18.

.2 Wrought copper and bronze: to ANSI B16.22.

2.7 Flanges - Copper Pipe

.1 Brass or bronze: to ANSI B16.15.

.2 Cast iron: to ANSI B16.4.

2.8 Valves General

.1 Include lock shield handles where shown or noted.

.2 Include chain wheel and chain where shown or noted.

.3 Use non-rising stem valves where there is insufficient clearance for stem to rise.

.4 Where butterfly valves are installed to permit removal of equipment, they shall be of the threaded full lug type. They may however, be of the wafer type if an additional pair of flanges (not those installed to contain the valve) are installed.

.5 Wherever possible all valves shall be of one manufacturer.

2.9 Gate Valves

.1 NPS 2 and under, screwed:

.1 Bronze body, rising stem, solid wedge disc, union or screwed bonnet.

.2 Acceptable Materials:

.1 Class 125 [860 kPa] - Crane 1700, Grinnell 3010, Kitz 24, Newman Hattersley 607, Nibco T-134, Toyo 293, or equivalent.

.2 NPS 2 and under, soldered:

.1 Bronze body, rising stem, solid wedge disc, screwed bonnet.

.2 Acceptable Materials:

.1 Class 200 W.O.G. [1380 kPa] - Crane 1700S, Grinnell 3080SJ, Kitz 44, Newman Hattersley 607C, Nibco S-134, Toyo 299, or equivalent.

.3 NPS 2-1/2 and over, flanged:

.1 Cast iron body, rising stem, O.S. & Y, solid wedge disc, bronze trim, bolted bonnet.

.2 Acceptable Materials:

.1 Class 125 [860 kPa] - Crane 465-1/2, Grinnell 6020A, Kitz 72, Newman Hattersley 504, Nibco F-617-0, Toyo 421A, or equivalent.

2.10 Globe Valves

.1 NPS 2 and under, screwed:

.1 Bronze body, rising stem, renewable composition or bronze disc, union bonnet.

.2 Acceptable Materials:

.1 Class 125 [860 kPa] - Crane 1703, Grinnell 3240, Kitz 03, Newman Hattersley 14, Nibco T-235-Y, Toyo 220, or equivalent.

.2 NPS 2 and under, soldered:

.1 Bronze body, rising stem, renewable composition or bronze disc, screwed bonnet.

.2 Acceptable Materials:

.1 Class 200 W.O.G. [1380 kPa] - Crane 1703S, Grinnell 3240SJ, Kitz 10, Newman Hattersley 51, Nibco S-211-YW, Toyo 212, or equivalent.

2.11 Butterfly Valves

.1 NPS 2-1/2 and over:

.1 Cast iron or ductile iron body with ductile iron plated or bronze disc, stainless steel stem and extended neck to clear minimum of 50 mm [2"] thick insulation.

.2 Threaded full lug type or wafer type (with or without integral flanges).

.3 Resilient EPT or EPDM seat.

.4 Operators (unless otherwise specified in Section 15900):

.1 NPS 4 and under - lever handle with minimum 10 position ratchet and disc position indicator.

.2 NPS 6 and over - worm gear operator.

.5 Acceptable Materials:

.1 Class 150 [1030 kPa] W.O.G. - Crane, Centreline, Demco, Dezurik, Grinnell, Keystone, Kitz, Kurimoto, Newman Hattersley, Nibco WD- 2100 or LD-2100, Norriseal, Apollo 141 or 143, or equivalent.

2.12 Ball Valves

.1 NPS 2 and under, screwed:

.1 Forged brass body, threaded cap, chrome plated ball, PTFE seats, blow out proof stem.

.2 Ball valves for isolation service shall have a large/full port.

.3 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.

.4 Acceptable Materials:

.1 Class 600 W.O.G. [4140 kPa] - Crane F9202, Grinnell 3700, Kitz 58, Newman Hattersley 1969, Nibco T-585-70, Toyo 5044A, Victaulic 722, or equivalent.

.2 NPS 2 and under, soldered:

.1 Forged brass body, threaded cap, chrome plated ball, PTFE seats.

.2 Ball valves for isolation service shall have a large/full port.

.3 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.

.4 Acceptable Materials:

.1 Class 500 W.O.G. [3450 kPa] - Crane F9222, Grinnell 3700SJ, Kitz 59, Newman Hattersley 1979, Nibco S-585-70, Toyo 5049A, or equivalent.

2.13 Balance Fittings and Valves

.1 NPS 1-1/4 and under:

.1 Bronze body and bronze trim, rising stem, renewable composition disc, globe type with memory stop, Lockshield, male union connection, angle and straight type.

.2 Acceptable Materials:

.1 Class 100 [690 kPa] - Dahl 13000-M series, Toyo 250 or 251, or equivalent.

.2 NPS 1-1/2 and over:

.1 Screwed connections up to NPS 2.

.2 Flanged connections NPS 2-1/2 and over.

.3 Cast iron body, non-lubricated eccentric plug with resilient coating EPT or RS 55, suitable for 121oC [250oF] operating temperature, stainless steel bearings, adjustable memory stop, plug type suitable for wrench adjustment.

.4 Acceptable Materials:

.1 Class 175 W.O.G. [1210 kPa] - DeZurik 400, Keystone Ballcentric, or equivalent.

2.14 2.14 Swing Check Valves

.1 NPS 2 and under, screwed:

.1 Bronze body, bronze swing disc, screw in cap, regrindable seat.

.2 Acceptable Materials:

.1 Class 125 [860 kPa] - Crane 1707, Grinnell 3300, Kitz 22, Newman Hattersley 60, Nibco T-413-B, Toyo 236, or equivalent.

.2 NPS 2 and under, soldered:

.1 Bronze body, bronze swing disc, screw in cap, regrindable.

.2 Acceptable Materials:

.1 Class 200 W.O.G. [1380 kPa] - Crane 1707S, Grinnell 3300SJ, Kitz 23, Newman Hattersley 61, Nibco S-413-B, Toyo 237, or equivalent.

.3 NPS 2-1/2 and over, flanged:

.1 Cast iron body, renewable or regrindable seat, bronze swing disc, bolted cap.

.2 Acceptable Materials:

.1 Class 125 [860 kPa] - Crane 373, Grinnell 6300A, Kitz 78, Newman Hattersley 731, Nibco F-918, Toyo 435A, or equivalent.

2.15 Silent Check Valves (Spring Type)

.1 NPS 2 and under, screwed:

.1 Bronze body, bronze trim, stainless steel spring, (heavy duty spring in vertical down flow application).

.2 Acceptable Materials:

.1 Class 125 [860 kPa] – Conbraco 61-500, Durabla, Grinnell 3600, Muessco 203BP, or equivalent.

.2 NPS 2-1/2 and over:

.1 Cast steel, wafer style, bronze trim, stainless steel spring (heavy duty spring in vertical down flow application).

.2 Acceptable Materials:

.3 Class 125 [860 kPa] - Apco, Centerline, Durabla, Duo-Chek II, Grinnell CV817, Nibco W-910, M & G, or equivalent.

2.16 Needle Valves

.1 Bronze body, screwed, globe type with cadmium plated steel stem.

.2 Acceptable Materials:

.1 Class 400 [2760 kPa] - Crane 88/89, RP&C 60-100, or equivalent.

.3 Application: Install needle valves where petcocks or manual vents are indicated.

2.17 2.17 Radiator Valves

.1 Screwed bronze body with bronze trim, wheel handle, rising stem, renewable composition disc, male union connections, angle and straight type.

.2 Acceptable Materials:

.1 Class 100 [690 kPa] - Dahl 11041 or 11042, Dunham Bush 200B or 246B, Kitz 100 series, Sarco type R or RP, Toyo 252 or 253, or equivalent.

2.18 Thermostatic Radiator Valves

.1 Screwed nickel plated brass body, stainless steel spindle, EPDM rubber valve disc, straight and angle type.

.2 Valves complete with sensors, operators and capillary tubing.

.3 Remote sensors/operators to have 8 m [26 ft] capillary tube.

.4 Capillary tubing to be run concealed in walls and ceilings, sheathed in 20 mm [3/4"] dia. plastic tubing.

.5 Acceptable Materials: Danfoss, or equivalent

.6 Notes:

.1 Valves in public areas to have valve mounted operators with remote wall mounted sensors.

.2 Valves on convector units to have valve mounted operators and sensors.

2.19 Drain Valves

.1 Globe type, bronze body with bronze trim and composition disc.

.2 Acceptable Materials:

.1 Crane 1703, Dahl 2343, Kitz 03, Newman Hattersley 13, Nibco T-235-Y, Toyo 220, or equivalent.

2.20 Hose Bibbs

.1 Brass ball valve with forged brass cap and chain, NPS 3/4 male threaded hose end, lockshield in public areas. Working pressure 1724 kPa [250 psi] to 121oC [250oF].

.2 Acceptable Materials:

.1 Crane F9202CC, DAHL #50-430 [50.430LS], Kitz 58CC, Red-White / Toyo 5046, or equivalent.

Part 3 Execution

3.1 Piping

.1 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly.

.2 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.

.3 Install piping to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.

.4 Maintain a minimum of 25 mm [1"] space between adjacent flanges or pipe insulation, whichever has the larger diameter.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.6 Saddle type branch fittings may be used on mains, if branch line is half size or smaller than main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Use long radius elbows.

.8 Install all thermometer wells and immersion sensor wells specified under Section 15900. Where wells will restrict flow in small diameter pipes (NPS 1-1/2 and smaller) install a section of oversized pipe at least NPS 2.

.9 Screw or weld (unless otherwise specified) all piping systems up to NPS 2.

.10 Weld (unless otherwise specified) all piping systems NPS 2-1/2 and over.

.11 Remake leaking joints using new materials, do not caulk or cement leaking threaded joints.

.12 Use eccentric reducers at pipe size changes, flush on top side, to permit positive venting and drainage.

.13 Do not use thread protection couplings, close nipples, running nipples or street elbows.

.14 Install dielectric type unions or flanges on "OPEN" type systems, where copper piping connects to steel. eg. domestic hot water tanks.

3.2 Pipe Grading

.1 Grade all piping to provide positive drainage and venting. Slope as follows:

.1 Supply mains and branches - up in the direction of flow, minimum 1:480 [1" in 40 ft].

.2 Return mains and branches - down in the direction of flow, minimum 1:480 [1" in 40 ft].

.3 Reverse return supply and return mains - up in the direction of flow, minimum 1:480 [1" in 40 ft.].

3.3 Soldering and Brazing

.1 Pressure fluid systems - with chemical treatment (heating) BRAZE with silver base brazing alloy, 538oC [1000oF] melting point.

.2 Pressure fluid systems - without chemical treatment, (domestic water) SOLDER with 95/5 tin-antimony.

.3 Non-pressure systems, (drains) SOLDER with 50/50 tin lead.

.4 Piping connections to radiant ceiling panels, SOLDER with 95/5 tin-antimony.

3.4 Drain Connections

.1 Pipe the discharge from all liquid relief valves, liquid safety valves, high capacity air vents, steam drip pan elbows, equipment blowdowns, water columns, overflows and piping system drains to the nearest building drain. Install a brass, bronze or copper receiving funnel on the drain where shown.

.2 Drains from drain pans shall be DWV copper ASTM B306 32 mm [1-1/4"] minimum size.

.3 Drain and vent piping shall be of the same material as the piping system to which it is connected, except where otherwise specified.

3.5 Expansion of Piping

.1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to equipment and building.

.2 Only major expansion configuration and fittings have been shown on the drawings.

.3 Provide all required additional compensators, loops and swing connections.

.4 Provide anchors, where shown. Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.

.5 Expansion loops shall be of all welded construction with long radius elbows.

.6 Install expansion loops, cold sprung 50% of the calculated expansion.

.7 Install at least three [3] elbows in all branch connections. Where space does not permit 3 elbows, install braided flexible pipe connectors in accordance with manufacturers recommendations. Three [3] elbow branch connections shall have sufficient developed length to ensure that excessive stresses are not generated in the piping and in no case less than 900 mm [36"].

3.6 Valves

.1 Install valves with stems upright or angled 45° above horizontal unless approved otherwise.

.2 Install control valves with their stems upright unless approved otherwise and with adequate clearance for removal of actuators.

.3 Use gate valves or (ball valves NPS 2 and under) to shut off branch takeoffs and to isolate equipment.

.4 Use globe valves to control flow in circuits; except where balancing cocks are specifically specified.

.5 Use plug type globe valves in control valve bypass connections.

.6 Use plug cocks for balance valves in water return branch mains and branch connections to return mains and for shut off and balancing on glycol circuits.

.7 Install balance fittings or valves in the return piping connections to each terminal heating unit - eg. radiators, unit heaters, fan coil units, heating coils.

.8 Install radiator valves in the supply connections to each convection heating element.

.9 Use swing check valves, in horizontal and vertical upflow pipes and on the discharge of pumps.

.10 Use silent check valves where specifically shown in vertical pipes with downward flow.

3.7 Drain Valves and Hose Bibbs

.1 Install drain valves and hose bibbs at each low point in the piping system and at specific drain locations shown on the drawings.

.2 Install NPS 3/4 hose bibbs at all downfed terminal heating and/or cooling units.

.3 Install NPS 1-1/2 or NPS 3/4 on line sizes less than NPS 1-1/2 drain valves / hose bibbs at all low points in the piping systems to facilitate draining.

.4 Install drain valves in lieu of hose bibbs for systems operating at over 93°C [200°F].

.5 Install a hose end adaptor on the discharge side of each drain valve or pipe to drain, where indicated.

.6 Use a NPS 1-1/2 firehose and connect it to the discharge side of the drain valves, to flush the piping system during the pipe cleaning process.

.7 Install caps, with chains, on hose end adaptors, in public areas.

3.8 Piping Tests

.1 Notify the Departmental Representative and the Inspection Authority having jurisdiction, 48 hours in advance of intended test dates.

.2 Before testing piping, isolate all equipment which cannot withstand the test pressure.

.3 Do not insulate, backfill or conceal until tests have been completed and approved by the inspection authorities.

.4 Examine all systems under test for leaks.

.5 Joints shall remain dry during the test. A general sweating around a weld shall be reason for rejection.

.6 Remake all leaking connections and joints.

.7 Tests shall be limited to new piping only.

.8 Initial Hydrostatic test:

.1 150% of working pressure, but not less than 860 kPa [125 psig] for 1 working day.

.9 Final Hydrostatic test:

.1 150% of working pressure, after piping connections to all equipment are complete, maintain until all parts of piping systems have been inspected.

3.9 Flushing and Cleaning

.1 Flushing and cleaning shall commence only after all piping tests have been completed.

.2 Install temporary bypass connections around all heat pump units before commencing chemical cleaning.

.3 Chemically clean the following piping systems as recommended by an approved professional chemical cleaning and treatment agency who shall supervise the work:

.1 Heating hot water system(s) and chilled water loop.

.4 Flush out all traces of chemicals with clean water after chemical cleaning is complete.

.5 Remove, clean and reinstall all strainer baskets.

.6 Submit a report signed by a principal of the Agency which certifies that the cleaning has been satisfactorily completed.

3.10 Chemical Treatment

.1 Chemically treat water systems in accordance with Section 23 25 00.

3.11 Testing and Balancing

.1 Balance all piping systems in accordance with the requirements of Section 23 05 93.

END OF SECTION

Part 1 General

1.1 Related Work

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

1.2 Reference Standards

.1 The provision of all specialty components shall be in accordance with ANSI/ASME B31 Codes for Building Services Piping.

1.3 Regulatory Requirements

.1 All water specialty components shall be provided in compliance with the Regulations and Requirements of the Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

1.4 System Pressure Ratings

.1 Piping systems 860 kPa [125 psig] or less operating pressure - 860 kPa [125 psig] rating.

Part 2 Products

2.1 Air Vents Automatic - High Capacity Type

.1 Non-Serviceable Type

.1 Casing and internal parts suitable for system operating pressure and temperature.

.2 All metal construction with outlet threaded to accept vent tubing connection.

.3 Automatic float type.

.4 Shrader type venting valve.

.5 Acceptable Materials:

.1 1035 kPa [150 psig] maximum operating pressure -Armstrong 11-AV, Maid-O-Mist 71, Taco 426, Watson McDaniel AE1800, or equivalent.

.2 Serviceable Type:

.1 Casing and internal parts suitable for system operating pressure and temperature.

.2 Automatic float type.

.3 Replaceable float, linkage, plug and seat.

.4 Acceptable Materials:

.1 1035 kPa [150 psig] maximum operating pressure -Armstrong 1-AV, Maid-O-Mist 71, Sarco 13W, Watson McDaniel AE1800R, or equivalent.

2.2 Air Vents Manual - High Capacity

.1 Globe Type

.1 Bronze body, union bonnet, screwed, 450 brinell hardened stainless steel trim and plug type disc.

.2 Acceptable Materials:

.1 Class 125 [860 kPa] - Crane 14-1/2 LP, Jenkins 2032, Lunkenheimer 73-PS, Toyo 214, or equivalent.

2.3 Air Vents Manual - Radiator Type

.1 Needle Type

.1 Bronze or steel body, screwed, needle valve.

.2 Manual key operator.

.3 860 kPa [125 psig] maximum operating pressure and 121°C [250°F] maximum operating temperature.

.4 Acceptable Materials:

.1 Maid-O-Mist 816, or equivalent.

.2 Hydroscopic Type

.1 Bronze or steel body, screwed, hydroscopic discs.

.2 Manual screwdriver or key operator.

.3 Acceptable Materials:

.1 345 kPa [50 psig] maximum operating pressure - Dunham Bush V19B, Maid-O-Mist 72, Taco 417, or equivalent.

.2 517 kPa [75 psig] maximum operating pressure -Maid-O-Mist 72, Taco 417, or equivalent.

2.4 Combination Balance/Check Valves

.1 Integrated shut off, non-slam check valve and balance valve.

.2 Suitable for 1029 kPa [150 psig] and 122oC [250oC].

.3 Cast iron body, stainless steel trim, bronze seat and disc.

.4 Connections:

.1 NPS 2 and under; screwed.

.2 NPS 2-1/2 and over; flanged.

.5 Select for system flow rate, and allowable pressure drop at a velocity not exceeding 1.8 m/s (6 fps).

.6 Acceptable Materials:

.1 Armstrong Flo Trex, Bell & Gossett Triple Duty, Taco Multi-purpose, Victaulic triple service valves, or equivalent.

2.5 Expansion Joints

.1 Copper Pipe Expansion Compensator - Low Pressure

.1 Bronze or stainless steel convoluted bellows.

.2 Suitable for up to 414 kPa [60 psig] working pressures.

.3 20 mm [3/4"] to 32 mm [1-1/4"] diameter, suitable for 12 mm [1/2"] compression and 6 mm [1/4"] extension.

.2 Steel Pipe Expansion Compensator

.1 Factory assembled unit, with stainless steel or phosphor bronze bellows in carbon steel casing.

.2 Antitorque groove in casing, internal pipe guide at both ends, full length internal liner.

.3 Suitable for 1035 kPa [150 psig] operating pressure.

.4 Suitable for 38 mm [1-1/2"] compression and 6 mm [1/4"] extension.

.5 Acceptable Materials:

.1 Adsco, Flexonics, Flextech Industries, Hydroflex, Metraflex, Vibra-Flo, or equivalent.

2.6 Expansion Tanks - Diaphragm Type

.1 Expansion tanks with a working pressure exceeding 207 kPa [30 psig] or with a diameter exceeding 610 mm [24"].

.1 Steel construction with sealed-in elastomer diaphragm suitable for up to 116°C [240°F].

.2 Manufactured in accordance with the requirements of ASME Section VIII, Pressure Vessels, Division 1, 860 kPa [125 psig] pressure rated.

.3 Identification plate showing:

.1 Manufacturer's name.

.2 Capacity in litres.

.3 Hydraulic test pressure.

.4 Working pressure.

.5 Code stamping and ASME registered design.

.4 Air precharged via air charging valve to a pressure of 83 kPa [12 psig].

.5 Saddles for horizontal installation or base mount for vertical installation.

.6 Acceptable Materials:

.1 Amtrol, Xilem, Expanflex, or equivalent.

2.7 Flexible Hoses - Braided

.1 Phosphor bronze convoluted bellows with braided bronze sleeve or stainless steel convoluted bellows with braided stainless steel sleeve.

.2 Suitable for system operating temperature and pressure.

.3 Connections:

.1 NPS 2 and under, screwed connections.

.2 NPS 2-1/2 and over, flanged connections.

.4 Length shall be as recommended by manufacturer, unless noted otherwise.

.5 Acceptable Materials:

.1 Flexonics Flex Con, Flextech Industries, Hydro Flex, Keflex, Vibra-Flo, or equivalent.

2.8 Flexible Pipe Connectors

.1 Flexible pipe connectors complete with control rods, manufactured from polyester tire cords and bridge bearing quality neoprene or EPDM; cover and liner to CSA Standard CAN3-S6-M88, Section 11.5.8.3. Provide flanges, bolts, etc. for outdoor installation. Do not make attachments between equipment and piping other than on equipment side of flexible connector.

.2 Twin sphere design with reinforcing ring.

.3 Safety factor for burst and flange pullout shall be a minimum of 3:1.

.4 Acceptable Materials:

.1 Mason Safeflex SFDEJ c/w Mason CR control rods, Flextech Industries, or equivalent.

2.9 Flow Control Valves - Automatic

.1 Body and internal parts suitable for maximum system temperature and pressure.

.2 Body fitted with inlet and outlet measuring connections.

.3 Devices shall automatically control the required flow quantity between differential pressure ranges of:

.1 7 to 96 kPa [1 to 14 psig].

.2 14 to 220 kPa [2 to 32 psig].

.3 27 to 390 kPa [4 to 57 psig].

.4 Provide a dual hose temperature/pressure meter kit with flow

conversion chart and carrying case.

.5 Acceptable Material:

.1 Griswold, or equivalent.

2.10 Circuit Balancing Valves

.1 NPS 2 and under: copper alloy body, screwed, 'Y' pattern globe.

.2 NPS 2-1/2 and over: cast iron body, flanged or grooved, 'Y' pattern globe.

.3 Maximum pressure 1715 kPa [250 psig] and maximum temperature 121°C [250°F].

.4 Calibrated balancing valve with memory, positive shut-off, inlet and outlet pressure measuring connections with integral shut-offs and drains.

.5 Calibration charts and adjustment tools to be included.

.6 Provide one (1) differential pressure meter kit suitable for direct readout c/w connection hoses suitable for the system pressure.

.7 Acceptable Materials:

.1 Bell and Gossett - Circuit Setter, or equivalent

.2 ESBE - Circuit Setter, or equivalent

.3 Tour & Anderssen - STAD, or equivalent

.4 Armstrong - CBV, or equivalent

.5 Wheatley - GS, or equivalent

2.11 Flow Measure Devices - Liquid

.1 Flow measuring device, to be sized to provide a readout signal between 2488 and 9954 Pa [10" to 40" W.G.].

.2 Where the required minimum straight pipe lengths cannot be provided for in-line devices, use elbow or venturi type devices.

.3 Each element shall be complete with instrument shut-off valves with finger tight connections and identification tag and chain.

.4 Each element shall be c/w a chained metal tag showing element size, location, volume, and differential signal.

.5 Acceptable Materials:

.1 Elbow Type - Measurell, or equivalent.

.1 NPS 2 and under: cast bronze elbow, screwed ends, 860 kPa [125 psig].

.2 NPS 2-1/2 and over: steel elbow, welded ends, 860 kPa [125 psig].

.3 Schedule 40: all fluids closed circuit.

.4 Schedule 80: on open circuits.

.1 In-line type - Verabar, Accutube, Flo-Probe, Preso, Valitube, or equivalent.

.1 NPS 1-1/2 and under: Verabar, Model C050 series, Schedule 40 pipe nipple with factory installed sensing probe, or equivalent.

.2 NPS 2 and over: Verabar, Model C100 series, standard insert sensor with 12 mm [1/2"] threaded weld coupling, or equivalent.

.3 Venturi type - Gerand, Preso, or equivalent.

.1 NPS 2 and under: brass screwed.

.2 NPS 2-1/2 and over: cast iron or steel, flanged, butt welded or roll grooved couplings where permitted.

.6 Provide a direct readout dial type meter complete with connecting hoses, and calibration charts to read the measured flow. Flow meter shall be calibrated in Pascals or mm of water column [inches of water] and shall be suitable for water/glycol. Hand over to Facilities at the completion of commissioning.

.1 Acceptable Materials:

.1 Eagle Eye, Gerand, Preso, Western Meter Model SCL101, or equivalent.

2.12 Pressure Reducing Station - Cold Water

.1 Screwed, bronze or cast iron body, suitable to 1380 kPa [200 psig], composition seat.

.2 Each reducing station to include:

.1 Gate valve, strainer, union, pressure reducing valve, union, gate valve.

.2 Bypass with globe valve.

.3 20 mm [3/4"] relief valve.

.3 Acceptable Materials:

.1 Cashco, Watts, or equivalent.

2.13 Pressure Relief Valves - Water

.1 Screwed, bronze body or cast iron body with expanded outlet.

.2 ASME rated.

.3 Coordinate with Heat Exchangers Schedules.

.4 Acceptable Materials:

.1 Bronze body: Watts 174A, NPS 3/4 to NPS 2, or equivalent.

.2 Iron body: Watts 740, NPS 3/4 x 1 to NPS 2 x 2-1/2, or equivalent.

2.14 Strainers

.1 NPS 2 and under: bronze body, screwed connections.

.2 NPS 2-1/2 and over: cast iron body, flanged connections.

.3 NPS 2 and over: Y or T type strainer with grooved ends with ductile iron body or malleable iron body.

.4 Suitable for maximum system operating pressure.

.5 Basket Screen:

.1 Bronze, stainless steel or monel perforated screen.

.2 35 holes/cm2, 1.2 mm dia. perforations, 36% open area.

.6 Acceptable Materials:

.1 Armstrong, Erwel, Kitz, Mech-Line, Muesco, Spirax/Sarco, Toyo, Victaulic, or equivalent.

2.15 Suction Guide

.1 Integrated long radius elbow, strainer and suction entrance guide vanes.

.2 Suitable for 1029 kPa [150 psig] and 122oC [250oF].

.3 Cast ductile iron body, stainless steel strainer, steel guide vanes.

.4 Connections:

.1 NPS 2 and under, screwed.

.2 NPS 2-1/2 and over, flanged.

.5 Select for system flow rate and allowable pressure drop.

.6 Acceptable Materials:

.1 Armstrong Suction Guide, Bell & Gossett Suction Diffusers, Mech-Line, Taco Suction Diffuser, Victaulic suction diffuser, or equivalent.

2.16 Test Plugs for Pressure / Temperature

.1 Provide 6mm [1/4"] NPT solid brass test plug fitting c/w brass chain where indicated.

.2 Test plugs shall be capable of receiving either a pressure or temperature 3mm [1/8"] O.D. Dual seal core shall be Nordel suitable for temperature of 177oC [350oF] and shall be rated zero leakage from vacuum to 6895kPa [1000psi).

.3 Provide one master test kit containing two test pressure gauge of suitable range, one gauge adaptor 3mm [1/8"] O.D. probe and two stem pocket testing thermometers of suitable range.

.4 Acceptable Materials:

.1 Sisco P/T Plugs, or equivalent.

.2 Flow Design - Superseal, or equivalent.

Part 3 Execution

3.1 Air Vents - Automatic - High Capacity Type

.1 Install automatic high capacity air vents at each high point in the piping systems and where shown on the drawings.

.2 Install on tees and not on horizontal pipe runs or elbows.

.3 Install a 12 mm (1/2") minimum isolating gate valve ahead of each air vent, unless air vent has an integral shut-off valve.

.4 Fit all vents on top of an air collecting chamber.

.5 Pipe all air vent discharge connections, (except for glycol) separately, to the nearest building drain, using 6 mm (1/4") hard drawn copper tube. Label ends with permanent labels.

.6 Pipe all air vent discharge connections, (except for glycol) separately, to a water-tight solder jointed, 1.2 mm (16 ga.) copper drain pan, using 6 mm (1/4") hard drawn copper tube where exposed and soft copper where concealed. Label ends with permanent labels.

3.2 Air Vents - Manual - High Capacity

.1 Install manual air vents at high points in the piping systems where shown on the drawings.

.2 Install on tees and not on horizontal pipe runs or elbows.

.3 Install isolating gate valve ahead of each vent valve.

.4 Pipe air vent discharge connections to nearest building drain.

.5 When using needle valves, run 6 mm (1/4") vent line down to needle valve at low level, complete with nipple and cap.

3.3 Air Vents Manual Radiator Type

.1 Install manual/automatic low capacity air vents on the return side of each water heating/cooling terminal element installed above the connection mains piping.

.2 Fit air vent on top of an air collecting chamber of NPS 3/4 pipe, 150 mm (6") high.

.3 Arrange air vents so that screwdriver slots or key openings are easily accessible.

.4 Drill access holes through radiation enclosures, where necessary.

.5 DO NOT USE on glycol systems.

3.4 Combination Balance/Check Valves

.1 Install combination stop/balance/check valves on the discharge of centrifugal pumps where shown on the drawings and/or where scheduled.

.2 Install in accordance with the manufacturer's recommendations.

.3 Minimum 5 pipe diameters from pump connections.

3.5 Expansion Joints

.1 Install expansion compensators at each location shown on the drawings.

.2 DO NOT test piping at higher pressures than the working pressure of the compensators.

.3 Take care to be aware of the temperature at which the expansion compensator is installed to properly establish the length.

3.6 Expansion Tank - Diaphragm Type

.1 Install expansion/contraction tanks at each location shown on the drawings and as scheduled.

.2 Install a gate valve in the system connection.

.3 Install a globe valve in the tank drain connection.

3.7 Flexible Hoses - Braided

.1 Install braided flexible hoses where shown on the drawings and as the flexible connections to designated heating/cooling terminal units.

.2 On screwed connections, install a union on one end.

.3 Take care not to torque the hose.

.4 Ensure braided flexible hoses are not damaged during hydrostatic testing.

3.8 Flexible Pipe Connectors

.1 Install convoluted and arched pipe connectors, for misalignment connections, where shown on the drawings.

.2 Install in accordance with manufacturer's recommendations.

3.9 Flow Control Valves - Automatic

.1 Install automatic flow control valves where shown on the drawings in accordance with the manufacturer's instructions.

.2 Hand over temperature/pressure meter kit and calibration charts to the Departmental Representative, at substantial performance and obtain receipt.

3.10 Circuit Balancing Valves

.1 Install flow measuring balancing valves where water balancing is required in accordance with the manufacturer's instructions.

.2 Hand over differential pressure meter kit and calibration charts to the Departmental Representative, at substantial performance and obtain receipt.

3.11 Flow Measuring Devices - Liquid

.1 Install the flow measuring devices in the piping circuits to establish the operational flow rates. Measuring devices shall be located where shown on the drawings.

.2 Install in accordance with the manufacturer's installation instructions and in the correct size of pipe. Reduce pipe size as required. Particular attention to be paid to required upstream and downstream straight pipe lengths.

.3 Install isolating globe, ball or needle valves with 6 mm (1/4") male end SAE flare connection on pressure tapping connections.

3.12 Pressure Reducing Stations - Cold Water

.1 Install water make-up stations for each hot water, chilled water and other closed water systems where shown on the drawings.

.2 Pipe relief valve to drain.

3.13 Pressure Relief Valves - Water

.1 Install pressure relief valve(s) on each heat exchanger to prevent over pressuring.

.2 Select relief valves to relieve full heat input of the heat supply side.

.3 Pipe relief valve to drain.

3.14 Strainers

.1 Install pipe line strainers where shown on the drawings.

.2 Provide isolation valves on either side of the strainer to permit cleaning without draining the system.

.3 Blowdown connections:

.1 Strainers, NPS 2 and under - hot services: nipple and cap.

.2 Strainers, NPS 2-1/2 and over - hot services: nipple, globe valve and nipple.

.3 Strainers, all sizes - cold services: plug.

3.15 Suction Guide

.1 Install suction guides on the suction of centrifugal pumps, where shown on the drawing and where scheduled in accordance with manufacturer's recommendations.

.2 "Start up" strainer baskets must be removed prior to commissioning of systems.

END OF SECTION

Part 1 General

1.1 Related Work

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

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 23 05 00 and 01 33 00.

.2 Submit shop drawings of pump curves with operating points indicated.

.3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.

.4 Submit motor efficiencies for all motors 1H.P. and over. Refer to Section 23 05 00 for minimum efficiencies.

1.3 General

.1 Motors powered by variable speed drive controllers shall be EEMAC Class B with Type F insulation, shall have a 1.15 service factor and shall be suitable to be driven by PWM variable speed drive controllers. The motor manufacturer shall submit in writing confirmation that the motors are designed to withstand voltage peaks of 1400 volts and a voltage rate of rise of 2000 volts / microsecond at a frequency of 20 kHz.

Part 2 Products

2.1 In-Line Circulator Pumps

.1 Suitable for a maximum working pressure of 860 kPa [125 psig] and maximum temperature of 107oC [225oF].

.2 Casing: Cast iron radially split, with flanged connections. Supplied with matching companion flanges.

.3 Impellor: Corrosion resistant cadmium plated steel.

.4 Shaft: Alloy steel with bronze sleeve bearing, integral thrust collar.

.5 Seal Assembly: Mechanical.

.6 Coupling: Flexible self-aligning.

.7 Motor: Resilient mounted, drip proof, sleeve bearing.

.8 Acceptable Materials:

.1 Aurora, Armstrong, Bell & Gossett, Grundfos, Leitch, Paco, Taco, or equivalent.

2.2 Vertical In-Line Centrifugal Pumps

.1 Suitable for a maximum working pressure of 1210 kPa [175 psig] and

maximum temperature of 107oC [225oF].

.2 Casing: Cast iron radially split, single stage, flanged suction and discharge connections, separate tapped openings for venting, draining and gauge connections.

.3 Impellor: Bronze dynamically balanced, keyed drive with locking nut.

.4 Shaft: Stainless steel on split coupled pumps and carbon steel with bronze sleeve on close coupled pumps.

.5 Seal Assembly: Inside unbalanced mechanical seal with factory installed seal flushing line.

.6 Coupling: Close coupled on motors less than 7-1/2 HP and split couplers for all motors 7-1/2 HP and larger to permit removal of seal without disturbing the motor.

.7 Motor: EEMAC Class B, squirrel cage induction, continuous duty, drip proof, ball bearings.

.8 Accessories: Strainer/suction guide, combination check/balance valve where scheduled.

.9 Acceptable Materials:

.1 Aurora, Armstrong, Bell & Gossett, Grundfos, Leitch, Paco, Taco, or equivalent.

Part 3 Execution

3.1 Installation

.1 In-line Circulators:

.1 Install as indicated by flow arrows.

.2 Support at flanges on outlets of unit.

.3 Install with bearing lubrication points accessible.

.2 General:

.1 Ensure that pumps are installed and aligned such that no piping or equipment loads are imposed on the pump body. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.2 Check pump rotation.

.3 Pipe drain tapping to floor drain.

.4 "Start-up" strainer baskets in strainer/suction guides must be removed prior to commissioning of systems.

END OF SECTION

Part 1 General

1.1 Related Work

.1 All sections of Division 23 Specifications form part of Contract Documents and are to be read, interpreted and coordinated with all pages. Conform to General Conditions and Division; Instructions to Bidders, Contract General Conditions and Supplements thereto form part of this Division and contain items related to mechanical work.

1.2 Scope

.1 Provide for cleaning and degreasing of all systems that use glycol or water as a heat transfer medium. (chilled water, hot water and heat pump heat recovery loops)

.2 Provide for cleaning and disinfection of domestic hot and cold systems.

.3 Provide all temporary strainers, connections and by-pass lines as required.

.4 Provide equipment to add chemicals to the systems as specified herein.

.5 Provide equipment to operate and control the system as specified herein. Provide appropriate protection so that capped off unused piping does not corrode.

.6 Provide corrosion coupons for all closed and open loop circulation systems as specified herein.

.7 Piping systems to be chemically treated include the following new systems:

.1 Chilled water system.

.2 Hot water heating system.

.3 Glycol system.

1.3 Quality Assurance

.1 The water treatment chemicals and treatment process shall be supplied and performed by the Contractor. This work shall be supervised by the Water Treatment Specialist who, upon completion shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.

.2 Notify Consultant 48 hours prior to chemical cleaning so that work may be verified and inspected.

1.4 Reference Standards

.1 Do HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of regulating authorities, except where specified otherwise.

1.5 Submittals

.1 Submit shop drawings including proposed chemicals, quantities, calculations, procedures and equipment to be supplied. Provide written operating instructions and system schematics.

.2 Provide written report containing log and procedure of system cleaning, giving times, dates, problems encountered and condition of water.

.3 Submit written report containing test results and list of chemicals added every 14 days from time of commissioning to acceptance.

.4 Provide monthly visits to check chemical treatment, take water samples and recommend any necessary changes to treatment. Provide written report.

1.6 Water Treatment Service

.1 The Water Treatment Specialist shall provide supervision of installations, set-up and adjustments and shall submit a written report on system operations.

.2 All chemicals, feed systems and test equipment shall be provided by the Water Treatment Specialist.

.3 Treatment chemicals shall not contain hydrazene.

.4 Treatment chemicals shall be non-foaming.

.5 The Water Treatment Specialist shall instruct the maintenance personnel before substantial completion. Written instructions of the treatment, dosages control charts and test procedures shall be included in the maintenance manuals.

.6 The Water Treatment Specialist shall provide monthly visits to check chemical treatment, take water samples and recommend any necessary changes to treatment, and provide a written report for a period of one year after substantial completion. Provide sufficient chemicals to treat the system from the time of commissioning to acceptance of the building. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation. The minimum amount of chemicals provided shall include the following:

.1 One spare drum (200L) of chemicals for each open system requiring treatment.

.2 One spare pail (20L) of biocide for each open system requiring treatment.

.3 One spare pail (20L) of chemicals for each closed system requiring treatment.

.7 Provide a test kit suitable for all chemical treatments used. The test kit shall be made available for on-site tests and provide a Myron 3 range TDS

meter to check conductivity. Hand over the kit to the Building Operator at project completion - obtain receipt.

.8 Provide one mild steel and one copper corrosion coupon package to monitor corrosion rate for each open and closed systems.

Part 2 Products

2.1 Materials

.1 System Cleaner: Use a Sodium Metasilicate, Sodium Nitrite and a wetting agent compound which in solution removes grease and petroleum products. Concentration level to be determined by Water Treatment Specialist (PACE Chemicals Ltd. - PURGEX L-24, or equivalent).

.2 Closed System Treatment (Hot Water, Chilled Water, Heat Pump, Heat Recovery including Dry Fluid Cooler Loop): Use an all-organic based corrosion inhibitor. Maintain levels at 60 to 100 ppm (PACE Chemicals Ltd. - BAR COR CWS-105, or equivalent). Note: The use of Nitrite only, Molybdate only or Sulphite only will not be accepted.

.3 Glycol System: Charge hot water and/or heat recovery system(s) and (heat pumps, heat recovery, loop serving, DHW pre heat) system(s) with a 30% solution of inhibited propylene glycol equivalent to DOWFROST.

.4 Provide sufficient chemicals to treat the system from the time of commissioning to acceptance of the building. In addition, provide a stock of chemicals, filters and corrosion coupons suitable for twelve (12) months normal operation.

.5 Materials which may contact finished areas must be colourless.

2.2 Equipment

.1 Closed System (Heating or Cooling)

.1 Bypass Pot Feeder: All closed hot water and chilled water systems shall have a by-pass chemical pot feeder with a 7.6 litre capacity. It shall be constructed of heavy duty cast iron or welded steel (suitable for 1380 kPa [200 psi] working pressure), with quick opening cap and complete with 20 mm NPT connections. Isolating valves shall be installed on the inlet, outlet and drain.

.2 Sidestream Filter: All closed hot water and chilled water systems shall have a sidestream filter housing of steel construction using a 250 mm x 30 micron filter cartridge, with a minimum flow rate of 35 litres/minute. A Flow Indicator shall be installed in conjunction with the sidestream filter. Connections shall be 20 mm MxFNPT and all isolating valves shall be installed as per manufacturer's instructions. Include 6 filter cartridges.

.3 Totalizing Make-up Water Meter: Cast Bronze body, 20 mm NPT connections, thermoplastic rotor and gear train, rated at 1034 kPa [150 psi] maximum operating pressure.

.4 Flow indicator

.5 Chemical Feed Piping:

.1 Schedule 40 black steel

.6 Corrosion Coupon and Holder Assembly:

.1 Mild steel corrosion coupon.

.2 Holder, 20 mm or 25 mm NPT male connection.

.3 Provide malleable or cast iron cross, 20 mm or 25 mm NPT female connection.

.2 Glycol System

.1 Label all drain valves with "GLYCOL - DO NOT DRAIN".

.2 Pre-mix solution in mixing tank, demonstrate specific gravity of solution to Departmental Representative and charge system using feed pump. After system has been filled, check specific gravity of solution in each system. Leave mixing tank filled with specified glycol solution. Secure cover lid.

.3 Glycol Feed System: Manual feed system including the following;

.1 Tank: 205 litre cylindrical, polyethylene tank with hinged poly cover and steel support stand with agitator bracket (Neptune Model TM 50PT, or equivalent).

.2 Pump: Hand operated fill pump, diaphragm style, 250 kPa (85 ft.) minimum head, 20 mm NPT connections, equivalent to Monarch L-30A.

.3 Pipe & Fittings: Pump suction shall be piped using 20 mm S40 PVC pipe and S80 PVC fittings. A 20 mm PVC ball valve and Y-Strainer shall be provided in the pump suction. The pump discharge shall be piped using 20 mm S80 PVC pipe and fittings. A 20 mm PVC ball valve and check valve shall be provided in the pump discharge line. Supply a 65 mm pressure gauge (0-600 kPa range) in the discharge piping.

.3 Test Kits:

.1 Provide test kits to determine proper systems treatment, including but not limited to the following

Part 3 Execution

3.1 Pre-Operational Cleaning And Chemical Treatment

.1 All systems must be chemically cleaned and flushed before water treatment is added. This includes partial or complete filling for pressure testing.

.2 Provide drain connections to drain system in one hour.

.3 All drains for chemical treatment shall be piped to the sanitary sewer.

.4 Install totalizing water meter(s) and record capacity in each system.

.5 After all components of the piping system have been pressure tested and proven to be in full operational condition and leak free, flush entire system with fresh, clean make-up water to remove loose mill scale, sediment and construction debris.

.6 After initial flushing has been completed, clean all strainer screens.

.7 System pumps may be used for cleaning, provided that pumps are dismantled and inspected, worn parts repaired with new gaskets and seals installed. Submit used seals.

.8 Add cleaner to closed systems at concentration levels recommended by the Water Treatment Specialist.

.9 For hot water heating systems, apply heat while circulating, raise temperature slowly to 70C and maintain at 70 C for minimum of 12 hours. Remove heat and circulate at 40 C or less. After cleaning, drain system as rapidly as possible. Flush system by opening drain valves and opening bypass valve on water make-up to system. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Install corrosion coupons, refill system and immediately add water treatment to proper level.

.10 For chilled water systems, circulate for 48 hours. After cleaning, drain system as rapidly as possible. Flush system by opening drain valves and opening bypass valve on water make-up to system. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Install corrosion coupons, refill system and immediately add water treatment to proper level.

.11 Use neutralizing agents upon recommendation of the Water Treatment Specialist and as approved by Departmental Representative.

.12 Inspect, remove sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

.13 Flush open systems with clean water for minimum of one hour. Drain completely and refill. Continue flushing until tests show pH, Iron, TDS and Chloride levels of water leaving system are the same as entering system. Stop flushing. Immediately add corrosion inhibitor and test to ensure proper level.

3.2 Cleaning And Chlorination Of Potable Water Piping

.1 All domestic water piping shall be thoroughly flushed so that it is free from scale, sediment, construction debris etc.

.2 On completion of installation and testing of the potable water systems, pre-flush, chlorinate with Sodium Hypochlorite to AWWA C651-05 specifications and let stand for 24 hours. Thoroughly flush again until flush water meets AWWA standards.

.3 Retain an independent inspection firm to supervise and inspect the chlorination and flushing procedures and perform chemical tests as required.

.4 Submit to the Departmental Representative, a certificate from the testing firm, stating that the chlorination and flushing have been successfully carried out.

.5 Acceptable Materials: PACE Chemicals Ltd., GE Betz Dearborn, or equivalent.

3.3 Glycol Antifreeze Systems

.1 Label all drain valves with "GLYCOL - DO NOT DRAIN".

.2 Pre-mix solution in mixing tank, demonstrate specific gravity of solution to Consultant at sample points and charge system(s) using feed pump. After system has been filled, check specific gravity of solution in each system. Leave mixing tank filled with specified glycol solution.

END OF SECTION

Part 1 General

1.1 Related Work

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

.2 Refer to Section 23 05 49 for required seismic restraint of ductwork.

1.2 Submittals

.1 Submit a schedule indicating the ductwork standards to be used, including metal gauges, joints and reinforcements before construction of any ductwork.

1.3 Reference Standards

.1 The construction and installation of ductwork and plenums shall be in accordance with the latest edition of the following referenced SMACNA manuals and ASHRAE handbooks.

.1 SMACNA - H.V.A.C. Duct Construction Standards.

.2 SMACNA - H.V.A.C. Air Duct Leakage Test Manual.

.3 ASHRAE - Handbook - Equipment Volume.

1.4 General

.1 Duct sizes on drawings indicate clear inside dimensions. For acoustically lined or internally insulated ducts, maintain inside duct dimensions.

.2 Where duct sizes are shown in nominal metric sizes, round and oval duct sizes may be supplied in the nearest available sizes in equivalent imperial units.

.3 Proper sized openings shall be arranged for in the correct locations through all slabs and walls. Openings shall be planned to include for the installation of fire dampers at all rated fire separations.

.4 Where ducts penetrate roofs, provide roof curbs with flashing and counterflashing.

.5 Arrange for 100 mm [4"] high by 100 mm [4"] wide concrete curbs around all duct penetrations through floor slabs outside of duct shafts.

.6 The project drawings are diagrammatic and although efforts have been made to provide information regarding the number of offsets and transitions, not all are necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. All required adjustments shall be established when coordinating and field measuring the work prior to fabrication and must be provided as part of the contract and all associated costs must be considered and included.

Part 2 Products

2.1 Galvanized Steel

.1 Galvanized steel shall have a 380 g/sq.m. [1-1/4 oz/sq.ft] galvanizing coat both sides to ASTM A525 G90.

2.2 Ductwork and Plenum Pressures

.1 Provide ductwork and plenums fabricated from galvanized steel for the static pressure categories listed below.

.1 1000 Pa [4" W.G.] static pressure.

.1 1500 Pa [6” W.G.] static pressure.

.2 All supply air ductwork downstream from supply air handling units discharge, to the upstream side of air valves or reheat coils.

.1 Air Handling Units AHU-1SF & 1EF

.2 750 Pa [3" W.G.] static pressure.

.1 All supply air ductwork downstream from smoke dampers (leaving duct shafts or leaving mechanical room wall) up to the upstream connections to mixing boxes.

.2 All outdoor intake plenums in mechanical room(s).

.3 All exhaust and return air ductwork and plenums from the inlet side of exhaust/return air fans in mechanical room, upstream to the furthest smoke damper/fire damper emerging from the duct shafts.

.3 500 Pa [2" W.G.] static pressure

.1 All supply ductwork downstream from air valves or reheat coils to terminal air outlets.

.2 All supply ductwork and plenums on systems without air valves.

.3 All return air ductwork and plenums, except where otherwise specified.

.4 All exhaust and relief air ductwork and plenums, except where otherwise specified.

.5 All outdoor air ductwork and plenums, except as otherwise specified.

2.3 Ductwork - 500 Pa [2" W.G.] Static Pressure

.1 Provide galvanized iron ductwork for system operating pressures 500 Pa [2" W.G.] and less. Ductwork shall be constructed, reinforced, sealed and installed to withstand 1-1/2 times the working static pressure.

.2 Construct rectangular ductwork in accordance with Section I including Tables 1-5, 1-10, 1-11, 1-12, 1-13 and Figs. 1-4 through 1-18 of the SMACNA Duct Standards.

.3 Nomasco "Ductmate System, Lockformer TDC ", Exanno "Nexus System", or equivalent, may be used for rectangular duct joints.

.4 At least two opposite faces of all rectangular ductwork must be joined together using a type of joint, which cannot pull apart.

.5 Construct rectangular duct fittings in accordance with Section II including Figs. 2-1 to 2- 11 and Figs. 2-16 to 2-18 of the SMACNA Duct Standards.

.6 Construct round ductwork in accordance with Section III including Table 3-2 and Figs. 3- 1 and 3-2 of the SMACNA Duct Standards, but excluding beaded crimp joints and snaplock seams.

.7 Construct flat oval ductwork in accordance with Section III including Table 3-4 and Fig. 3-6 of the SMACNA Duct Standards. Joints and seams shall be similar to those indicated for round ducts. Flat oval duct to be used for positive pressure application only.

.8 Construct round and flat oval duct fittings in accordance with Section III including Table 3-1 and Figs. 3-3 through 3-6 of the SMACNA Duct Standards. Round elbows shall have a centreline radius of 1.0 times duct diameter. Sheet metal gauge of fittings and elbows shall be not less than the thickness of that specified for longitudinal seam straight duct. Adjustable elbows are not permitted.

2.4 Ductwork - 750 Pa [3"] and Greater Static Pressure

.1 Provide galvanized iron ductwork for system operating pressure over 500 Pa [2" W.G.]. Ductwork shall be constructed, reinforced, sealed and installed to withstand 1-1/2 times the working static pressure.

.2 Construct rectangular ductwork in accordance with Section I including Tables 1-6 through 1-13 and Figs. 1-2 through 1-18 of the SMACNA Duct Standards.

.3 Nomasco "Ductmate System", Exanno "Nexus System", "Lockformer TDC, TDF system", or equivalent may be used for rectangular duct joints.

.4 Construct rectangular duct fittings in accordance with Section II including Figs. 2-1 through 2-11 of the SMACNA Duct Standards.

.5 Construct round ductwork in accordance with Section III including Table 3-2 and Figs. 3- 1 and 3-2 of the SMACNA Duct Standards.

.6 Construct flat oval ductwork in accordance with Section III including Table 3-4 and Fig. 3-6 of the SMACNA Duct Standards. Joints and seams shall be similar to those indicated for round duct. Flat oval duct to be used for positive pressure application only.

.7 Construct round and flat oval duct fittings in accordance with Section III including Table 3-1 and Figs. 3-3 through 3-6 of the SMACNA Duct Standards. Round elbows shall have a centreline radius of 1.5 times duct diameter. Construct 90 deg. elbows of not less than 5 tapered sections. All seams and joints in round or oval duct fittings and elbows shall be spot welded lap seams at not more than 50mm [2"] spacing and all inside seams sealed with approved duct sealant. If the zinc coating is burned off the steel during welding, the joints shall be painted to prevent corrosion. Sheet metal gauges of fittings and elbows shall be not less than the thickness of that specified for longitudinal seam straight duct but suitably thick for welding methods used.

2.5 Plenums - 500 Pa [2"] Static Pressure

.1 Provide galvanized steel low pressure plenums suitable for 500 Pa [2" W.G.] positive or negative pressure, for central plant ventilating and air conditioning equipment.

.2 Construct plenums in accordance with Section VI including Figs. 6-1 through 6-3 of the SMACNA Duct Standards.

.3 Where the building structure does not form the bottom surface of a walk-in plenum, fabricate plenum floor panels of 1.78 mm (14 ga.] galvanized steel, with angle iron reinforcing such as to limit deflection of the floor panels to a maximum of 6.4 mm [1/4"] under a concentrated load of 115 kg [250 lbs] at mid span.

.4 Where plenum floors are internally lined, install a 1.47 mm [16 ga.] thick galvanized steel panel on top of the insulation.

.5 Apply silicone sealant CGE Silpruf 2000 series or Dow Corning 781/732, or equivalent, between plenum base angles and concrete or curbs before bolting together.

.6 Reinforce all openings in plenum walls with 40 mm x 40 mm x 4.8 mm [1-1/2" x 1-1/2" x 3/16"] angle iron, secured to the main vertical and horizontal reinforcing angles.

.7 Arrange access doors so that they open against the air flow and static pressure.

.8 Weld all joints on condensate drain pans. Construct the pans from 1.45 mm [16 ga.] thick stainless steel type #302 or #304. Install a minimum of 32 mm [1-1/4"] piping connection, complete with water seal at least 100 mm [4"] deep, from the pan drain connection to the nearest building drain. Install drain connections so that they shall completely drain the pans.

.9 Seal piping penetrations through plenum walls, with gland seals as detailed in Fig. 6-10 of the SMACNA Duct Standards.

.10 Bulkheads mounting air filters and air coils shall be airtight to prevent air bypass around filters and/or coils.

2.6 Plenums - 750 Pa [3"] and Greater Static Pressure

.1 Provide medium/high pressure galvanized steel plenums for central plant ventilating and air conditioning equipment suitable for the specified pressures.

.2 Construct plenums in accordance with Section VI including Figs 6-3 through 6-9 of the SMACNA Duct Standards. If requested, pressure test the plenums to the specified static pressure (positive or negative) to demonstrate the structural integrity.

.3 Where the building structure does not form the bottom surface of a walk-in plenum, fabricate plenum floor panels of 1.78 mm [14 ga.] galvanized steel, with angle iron reinforcing such as to limit deflection of the floor panels to a maximum of 6.4 mm [1/4"] under a concentrated load of 115 kg [250 lb.] at mid span.

.4 Where plenum floors are internally lined, install a 1.47 mm [16 ga] thick galvanized steel panel on top of the insulation.

.5 Apply silicone sealant, CGE Silpruf 2000 series or Dow Corning 781/732, or equivalent, between plenum base angles and concrete or curbs, before bolting together.

.6 Reinforce all openings in plenum walls with 50 mm x 50 mm x 6.4 mm [2" x 2" x 1/4"] angle iron secured to the main vertical and horizontal reinforcing angles.

.7 Arrange access door so that they open against the air flow and static pressure.

.8 Weld all joints on condensate drain pans. Construct the pans from 1.45 mm [16 ga.] thick stainless steel type #302 or #304. Install a 32 mm [1-1/4"] piping connection complete with water seal, from the drain pan connections to the nearest building drain. Install drain connections so that they shall completely drain the pans.

.9 Water Seal Depth:

.1 130 mm [5"] for 750 Pa [3" W.G.] systems.

.2 150 mm [6"] for 1000 Pa [4" W.G.] systems.

.3 200 mm [8"] for 1500 Pa [6" W.G.] systems.

.4 300 mm [12"] for 2500 Pa [10" W.G.] systems.

.10 Seal piping penetrations through plenum walls with gland seals as detailed in Fig. 6-10 of the SMACNA Duct Standards.

.11 Bulkheads mounting air filters and air coils shall be air tight to prevent air bypass around filters and/or coils.

2.7 Ductwork – Acoustically Lined

.1 Where rectangular ductwork is indicated to be acoustically insulated with flexible acoustic duct liner, shall be installed in accordance with instructions and Figures 2-22 through 2-25, SMACNA Duct Standards. Duct sizes shown are inside the duct liner.

.2 Where round ducts with 25 mm [1"] thick flexible fibrous glass duct liner between the two ducts. The inner duct shall be suitable for the static pressure and shall be sealed airtight where it joins the adjacent ductwork.

2.8 Coil End Covers

.1 Provide coil end casings to eliminate coil frame air leakage.

.2 Provide for cooling coil ends to drip condensate to the coil drain pan. Insulate the inside of the coil end casing to prevent casing condensation and provide closure panels to retain insulation.

2.9 Wire Mesh Screens

.1 Provide wire mesh screens in all air intake openings where noted on the drawings.

.2 Screens shall be constructed from aluminum wire 1.3 mm diameter [16 ga].

.3 Screen mesh shall be 12.7 mm [1/2"].

.4 Mount screens in 0.66 mm thick [20 ga] folded aluminum frames.

Part 3 Execution

3.1 Ductwork & Plenum Installation

.1 Where a duct contains a fire or smoke damper, construct the duct so that the free area of the duct is maintained through the fire or smoke damper.

.2 Where a duct is to be internally insulated, enlarge the duct so as not to reduce the duct free area.

.3 Make the taper of diverging transitions less than 20 deg. and the taper of converging transitions less than 30 deg., in accordance with Fig. 2-9 of the SMACNA Duct Standards. Maximum divergence upstream of equipment to be 30 deg. and 45 deg. convergence downstream.

.4 Make the inside radius of any rectangular duct elbow at least equal to the duct width, measured in the direction of the radius. If space conditions do not permit a full radius elbow to be installed, use square elbows with multi-blade turning vanes.

.5 Turning vanes shall be single wall type. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 0.76 mm [22 ga]. Vanes shall be spaced at 40 mm [1-1/2"] centres and shall turn through 90 deg., with a radius of 50 mm [2"]. Vanes shall not include a

straight trailing edge. Refer to Figs. 2-3 and 2-4 of the SMACNA Duct Standards. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 0.86 mm thick [18 ga].

.6 For 500 Pa [2"] pressure systems, install tie rods to limit the maximum unsupported vane length to 914 mm [36"]. Refer to Fig. 2-4 of the SMACNA Duct Standards.

.7 For 750 Pa [3"] and greater pressure systems, install tie rods to limit the maximum unsupported vane length to 460 mm [18"]. Refer to 2-4 of the SMACNA Duct Standards.

.8 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs as required to suit site conditions.

.9 Where indicated, install adjustable air turning devices, where full radius take-off fittings cannot be installed, in accordance with Fig. 2-16 of the SMACNA Duct Standards. Adjustment shall be accessible outside the duct with lockable quadrant operator or through the grille or register with key-operated worm gear mechanism.

.10 Cross-break or bead all metal duct panels unless otherwise noted.

.11 Do not cross-break duct panels on 750 Pa [3"] and greater static pressure systems.

.12 Do not cross-break bottom duct panels when ductwork is handling moisture.

.13 Grade all ductwork handling moisture, a minimum of 1:120 [1" in 10 ft] back to the source or at low points in the ductwork, provide a 150 mm [6"] deep drain sump and 32 mm [1-1/4"] dia. drain connection with deep seal trap and pipe to drain.

.14 Construct ductwork handling moisture with three sided bottom sections and a separate top panel. Install the three-sided bottom sections and internally seal the transverse joints with CGE Silicone Sealant "Silpruf", or equivalent. Then install the top panels and seal the top panel seams and joints.

.15 Support ductwork using galvanized steel straps, cadmium plated threaded rods, flat bar or angle hangers. Attachments to the structure shall be compatible with the structure and selected for the load of the ductwork. Install ductwork hangers in accordance with Section IV including Tables 4-1 through 4-3 and Figs. 4-1 through 4-9 of the SMACNA Duct Standards.

.16 Support duct risers at their base and at each floor and at not greater than 3.7 m [12 ft] intervals.

.17 Arrange ductwork and plenums so that duct and plenum mounted equipment can be easily removed.

.18 Ducts passing through non-rated fire separations, sound insulated walls and through non- rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent passage of smoke and/or transmission of sound (U.L.C. approved fire stop sealant is not a requirement). Where ducts are insulated provide a 0.61 mm [24 ga] thick galvanized steel band tightly fitted around insulation and then caulk to band.

.19 During construction, protect openings in ductwork, from dust infiltration, by covering with polyethylene, and protect floor outlet duct openings with metal caps.

.20 Where ductwork is required to pass through open web steel joists, coordinate with the joist fabricator before fabricating ductwork.

.21 Where ducts penetrate roofs, install sleeves and roof curb c/w flashing and counterflashing. Pack sleeves in roof with fibreglass insulation.

.22 Underslab ducts to be installed in accordance with Section 3.4 including Figs. 3-11 and 3-12 of the SMACNA Duct Standards.

3.2 Ductwork Leakage Test

.1 Leakage test all 750 Pa [3"] and greater static pressure supply ductwork installed under this contract, as recommended in the SMACNA H.V.A.C. Air Duct Leakage Test Manual, 1985 Standards, to a static pressure 500 Pa [2" W.G.] in excess of the specified ductwork design static pressure.

.2 Use equipment capable of demonstrating leakage.

.3 Test the first 30 m [100 ft] of installed ductwork in the presence of the Departmental Representative.

.4 Test a 30m [100ft] section of 500 Pa [2"] static pressure ductwork, where complete systems over 30m [100 ft] long are installed under this contract to a static pressure of 500 Pa [2" W.G.].

.5 The total allowable leakage for the entire system shall be not greater than [5] percent of the total system capacity.

.6 Submit test reports for all ducts tested.

3.3 Ductwork and Plenum Cleaning

.1 Responsibility

.1 This Contractor shall be responsible for and ensure that all ductwork, installed under this contract is internally CLEAN, when handed over to the Departmental Representative. This responsibility includes the entire systems, from outdoor air intakes to air terminals and from air terminals to relief outlets. It includes all ductwork, lined and unlined, all plenums and all equipment within or connected to ducts and plenums.

.2 The surfaces shall be considered clean when all foreign materials capable of particulating and visible to the naked eye are removed.

.2 Installation Procedure

.1 All ductwork shall be wiped clean prior to installation.

.2 Close all dampers immediately following installation thus checking the operation and retarding movement of contaminants through the system.

.3 Seal all openings at the end of each day and at such other time as site conditions dictate.

.4 Floor openings to be capped with sheet metal or floor grilles plus 0.15 mm [6 mils] thick poly sheet.

.5 Other openings to be covered with 0.15 mm [6 mils] thick poly sheet taped so as to be air tight.

.3 Cleaning Procedure

.1 On completion of the duct and plenum installation and prior to the installation of air terminals and prior to balancing of the air systems, but not until the areas are substantially clean (floors have been swept and vacuumed) and all "dirty" construction has been completed, employ an approved Cleaning Agency to vacuum clean the following:

.1 All plenums.

.2 All supply and return air ducts.

.3 All exhaust air ducts.

.4 Smoke evacuation ducts.

.5 Relief ducts.

.2 All components within each system shall be thoroughly cleaned and shall include but not be limited to the following: coils, fans and motors, air terminals and air valves.

.3 After the duct systems have been cleaned they should be resealed if they are not being used. Provide filter media on the return air terminals if the return air fans are run after cleaning has been completed.

.4 The Cleaning Agency shall perform a full inspection of the duct interior.

.5 Spot checks will be made by the Departmental Representative during the cleaning process to verify that the required standard is being met. When substantial performance is claimed, final spot

checks will be made to verify that the ducts are clean. If any ducts are found to be unclean, then they shall be recleaned.

.6 Submit a report from the cleaning agency that certifies all specified air systems have been cleaned (complete Mechanical Form MF 171 in Section 23 06 02).

END OF SECTION

Part 1 General

1.1 Related Work

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

.2 Provide venting as part of boiler package; refer to Section 23 52 00 - Packaged Boilers.

1.2 Certification of Ratings

.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 Breeching and Chimneys - All Fuels

.1 Minimum Requirements:

.1 Factory-built seismically-rated sectional prefabricated double wall breeching and chimney.

.2 U.L.C. listed.

.3 Venting system is to comply with Category IV (positive exhaust pressure) venting system requirements in accordance with the latest edition of CAN/CSA B-149.1, as well as per boiler manufacturer recommendations.

.4 Accessories: The entire stack system from each boiler or appliance to the termination shall be from one manufacturer and shall include for all required components necessary such as pipe lengths, adjustable pipe lengths, tees, elbows, ventilated roof thimble, insulated exit cone termination, supports, guides, flanged boiler adaptor, joint sealant, angle rings, drain sections, etc.

.5 Acceptable Materials:

.1 Ampco, Cleaver Brooks, Metalbestos PS, IPS, Van-Packer DW, Metal-Fab PIC, or equivalent.

Part 3 Execution

3.1 Chimneys

.1 Install in accordance with manufacturers recommendations.

.2 Support chimneys at bottom, roof and intermediate levels as indicated. Install thimbles where penetrating roof, floor, ceiling.

.3 Install chimneys penetrating roofs as indicated, complete with flashings to suit installation. Use existing roof openings as practical; ensure roof water seal is maintained.

.4 Install guy wires as necessary.

.5 Exposed metal parts outside building to be painted with heat and corrosion resistant primer and finish paint.

3.2 Expansion Compensators

.1 Install in accordance with the manufacturer's recommendations.

.2 Provide adjacent breeching sections with oversize flanges as required to maintain clear inside breeching diameter through the compensator.

END OF SECTION

Part 1 General

1.1 Related Work

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

.2 Provide venting as part of the boiler package. Refer to Section 23 51 00 (venting, breeching and chimney). Venting shall meet manufacturer's and boiler manufacturer's recommendations and sizing.

1.2 Reference Standards

.1 Install packaged boiler(s) in accordance with current Regulations of the Province of B.C., CSA B51, ASME Codes, CSA B140.7.2., CAN1-3., Canadian Electric Code, CSA B139, CSA B139S1, CAN1-B149.1, ANSI B31.1, except where specified otherwise.

1.3 Submissions

.1 Submit certificate of inspection from B.C. Boiler Pressure Vessel Safety Branch – Technical Safety BC.

1.4 Warranty

.1 The boiler manufacturer shall warrant each boiler, including boiler, trim, boiler control system, and all related components, accessories, and appurtenances against defects in workmanship and material for a period of twelve (12) months from date of startup.

.2 The boiler manufacturer shall warrant the boiler's heat exchanger and fuel burner for a period of five (5) years from date of startup.

Part 2 Products

2.1 General

.1 Packaged boiler: complete with burner and necessary accessories and controls, and ready for attachment of water supply, return and drain piping, fuel piping, electrical connections, and chimney connection.

.2 Modulating boiler with minimum 6:1 turndown.

.3 Designed and constructed in accordance with CSA and ASME Code requirements, including:

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-(2017) and Section IV ("H" Stamp Heating Boilers).

.2 CAN1-3.1-77(R2016), Industrial and Commercial Gas-Fired Package Boilers.

.3 CSA B51-[09], Boiler, Pressure Vessel, and Pressure Piping Code.

.4 CSA B149.1-15, Natural Gas and Propane Installation Code.

.5 ANSI Z21.13-[17]/CSA 4.9-[17], Gas-Fired Low-Pressure Steam and Hot Water Boilers.

.6 Electrical and Electronic Manufacturers Association of Canada (EEMAC)

.7 ASME CSD-1 (Controls and Safety Devices)

.4 Electrical components CSA approved.

.5 Approved by:

.1 B.C. Boiler Inspection Department

.2 B.C. Gas Inspection Department

.6 Boilers to be test fired before shipment and to be registered with the Provincial Authorities.

.7 Include erection and wiring diagrams and an operating and maintenance manual with boiler package.

.8 Check all available drawings and ensure that the boiler proposed will fit in the space allotted and can be maintained and operated in a normal manner without difficulty.

2.2 Boilers – Finned Tube

.1 General requirements:

.1 Unit(s) shall be forced draft, factory "packaged" low pressure hot water boiler(s), comparable to existing being replaced. Each factory "packaged" boiler shall be complete with all components, accessories and appurtenances necessary for a complete and operable boiler, with all safeties, to meet operating requirements and local regulations. Each unit shall be furnished factory assembled with required wiring and piping as a self-contained unit. Each unit shall be readily transported and ready for installation. Complete unit shall comply with all requirements of state and local codes.

.2 Each factory "packaged" boiler, including pressure vessel, trim, valve trains, burner, control system, and all related components, safeties, accessories and appurtenances shall all be assembled and furnished by the boiler manufacturer. The boiler manufacturer shall provide unit responsibility for the engineering, coordination, workmanship, performance, warranties, and all field services for each factory "packaged" boiler as specified herein. The boiler manufacturer shall be fully responsible for all components assembled and furnished by him whether or not they are of his own manufacture. The boiler manufacturer shall also be responsible for flue vent supply.

.3 Each boiler shall be capable of operating continuously at rated capacity while maintaining an CSA (formerly AGA & CGA) certified thermal efficiency of not less than 85 %.

.4 Boiler operating pressure shall be 100 psig.

.5 Boiler design pressure shall be 160 psig.

.6 Fuel shall be natural gas with an assumed higher heating value of 1,050 Btu/Cu Ft and an assumed specific gravity of 0.60 (relative to air). Natural gas shall be supplied at a pressure of no less than 4" w.c. and no more than 14" w.c. to the inlet of the gas train.

.7 Power voltage shall be 208-230 volts, 1-phase, 60 hertz, 4 wire (dedicated ground) with single point power connection. Control voltage shall be 120 volts, 1-phase, 60 hertz.

.8 Boiler shall undergo a Full Function Factory Fire Test and bear a fire test label.

.9 Boiler shall be registered through the National Board from the factory.

.10 The manufacturer shall make available, upon request, all quality assurance documentation and results of Full Function Factory Fire Test based on the boiler's serial number.

.2 Boiler construction:

.1 Each hot water boiler shall be of the vertical, water-tube, copper fin tube heat exchanger type complete with trim, valve trains, burner, and boiler control system. The boiler manufacturer shall fully coordinate the boiler as to the interaction of its elements with the burner and the boiler control system in order to provide the required capacities, efficiencies, and performance as specified.

.2 Each boiler heat exchanger shall be of the vertical, concentric, copper fin tube type with three pass, counter-flow design.

.3 All boiler pressure parts shall be constructed in accordance with the latest revision of the ASME Boiler and Pressure Vessel Code, Section IV, and shall be so stamped along with a National Board Registration number.

.4 All boiler heat exchanger tubes shall be not less than 7/8 inches I.D. with a wall thickness of not less than 0.065" thick. All boiler heat exchanger tubes shall be straight, solid copper tubes and shall incorporate an "extended" finned surface of integral, extruded, copper fins spaced not less than 7 fins per inch. Boiler heat exchanger tubes shall be arranged vertically. All tubes must be full size for the entire length of each tube and extend from the upper header to the lower header with no tube bends. Boiler tubes shall be arranged and spaced for the most effective distribution of combustion gas flow through the entire boiler heat exchanger to provide for maximum heat transfer. Baffles between tubes shall be unacceptable.

.5 Boiler heat exchanger headers shall be cast gray iron with end covers completely removable for inspection. Seals shall be EPDM O-rings, rated for 400 deg F service. Gaskets are not acceptable.

.6 Boiler heat exchanger tubes shall be rolled into the top and bottom header collectors.

.7 Boiler combustion chamber shall be fabricated from minimum No. 14 gauge aluminum and shall completely enclose the boiler heat exchanger. The combustion chamber shall be readily removable and re-installed.

.8 Boiler shall be enclosed with a single wall outer casing. The casing shall be airtight for pressurized operation. It shall completely enclose the boiler combustion chamber. It shall be fabricated from 16-gauge carbon steel with aluminum access panels. The front wall shall be tongue and groove fitted onto the sidewalls. The front and top wall shall be secured in place with bolts (sheet metal screws are not acceptable). Access panels shall be secured with quick opening ¼ turn fasteners. The complete outer casing shall be finished inside and out with a powder coated finish. There shall be an insulating air space between the combustion chamber and the outer casing. The composite structure of the boiler combustion chamber, insulating air gap and outer casing shall be of such thickness and materials to assure an outer casing temperature of not more than 50oF above ambient temperature when the boiler is operated at full rated load.

.9 An airtight observation port shall be located on the boiler to allow for observation of the burner flame.

.10 A flue gas outlet shall be located on the rear of the boiler. Boiler to be certified for installation with Category IV venting (stack) as defined in NFPA 54 (ANSI Z221). Forced draft burner shall be capable of firing against a back pressure of 2.0 inwc.

.3 Acceptable Materials:

.1 Harsco-PK, Laars, Lochinvar, Viessmann, or equivalent.

2.3 Boiler Connections

.1 Each boiler shall be provided with all necessary inlet and outlet connections. Boiler connections shall be as follows:

.1 One water supply outlet, 2-1/2“ FPT

.2 One water return inlet, 2-1/2“ MPT

.3 One relief valve outlet

.4 One flue gas vent outlet, with adapter as required, shall be included with the boiler.

.5 One fuel gas inlet, 1-1/2" size, FPT.

.6 One combustion air inlet

2.4 Boiler Trim and Safety Devices

.1 Each boiler shall be provided with all necessary trim and safety devices. Boiler trim shall include:

.1 One safety valve shall be provided in compliance with the ASME code

.2 One water pressure-temperature gauge.

.3 One primary low water flow fuel cutoff. The primary low water flow cutoff shall be a flow switch as required by ASME Code.

.4 One high limit water temperature controller to stop burner operation at excess water temperature (shall be manually reset).

.5 One operating temperature control to control the sequential and modulating operation of the burner.

.6 One secondary low water level fuel cutoff. The secondary low water level cutoff shall be a separate manual reset probe type controller.

2.5 Boiler Fuel Burning System:

.1 The boiler manufacturer shall furnish each boiler with an integral, pre-mixed, forced draft, straight gas, fully automatic fuel burner. The fuel burner shall be an assembly of gas burner, combustion air blower, valve train, and ignition system. The burner manufacturer shall fully coordinate the burner as to the interaction of its elements with the boiler heat exchanger and the boiler control system in order to provide the required capacities, efficiencies, and performance as specified.

.2 Each burner shall be provided with an integral gas firing combustion head, properly sized to admit the fuel gas to the burner. In addition, the gas combustion head shall be provided with a orifice plate to meter the air flow to the burner and maintain precise fuel-to-air mixture. Air and gas shall be mixed as they pass through the blower to assure maximum combustion efficiency.

.3 Each burner shall provide adequate turbulence and mixing to achieve proper combustion without producing smoke or producing combustibles in the flue gases.

.4 Each boiler shall be provided with an integral power blower to supply combustion air. The combustion air blower shall have sufficient capacity at the rated firing rate to provide air for stoichiometric combustion plus the necessary excess air. Static and total pressure capability shall comply with the requirements of the boiler. The blower motor shall be a maximum of 1 motor horsepower and operate without undue vibration and noise

and shall be designed and constructed for exposure to temperatures normal to its location on the boiler. The fan impellor shall be the non-sparking type, high efficiency, airfoil, backward inclined design.

.5 Each burner shall of the radial-fired type and constructed of steel with a stainless steel inner and woven stainless steel mesh outer screen, designed to produce a complete 360° flame pattern.

.6 Each boiler shall be provided with a "Full Modulating" firing control system whereby the firing rate is infinitely proportional at any point between 20% and 100% of maximum firing rate as determined by the input control signal. Both fuel and air control shall be completely "linkageless" to assure the proper fuel/air ratios to achieve maximum combustion efficiency.

.7 The combustion control system shall automatically compensate for changes to atmospheric pressure and/or inlet air temperature.

.8 Burner shall incorporate soft start controls, which controls the ramp up speed of the burner to avoid over-firing and subsequent short cycling.

.9 Fully modulating burner, with minimum 6:1 turndown.

2.6 Main Gas Valve Train

.1 Each boiler shall be provided with an integral main gas valve train. The main gas valve trains shall be factory assembled, piped, and wired. Each gas valve train shall include at least the following;

.1 Two manual shutoff valves (gas train inlet connection & mixer inlet).

.2 Two (2) safety shutoff valves.

.3 Linkageless Air – Gas ratio control (maximum inlet pressure 14" w.c.)

.4 One (1) low and (1) high gas pressure switch (manual reset)

.5 Air gas mixer

2.7 Ignition System

.1 Each boiler shall be provided with a factory installed, integral, interrupted electronic ignition system. Ignition system shall be removable for maintenance or replacement. Each ignition system shall include at least the following:

.1 A back pressure limit switch to shut down the burner in case of a blocked vent.

.2 An electronic spark generator with ignition cable and ignition electrode.

2.8 Combustion Air Control System

.1 Each boiler shall be provided with an integral combustion air control system. The combustion air system shall be factory assembled. Each combustion air control system shall include at least the following:

.1 A variable speed combustion air blower controlled against the water temperature.

.2 A low airflow differential pressure switch to ensure that combustion air is supplied.

2.9 Burner Control System

.1 The control system shall be supplied for 120 volts, single phase, 60 hertz. The power supply to each boiler shall be protected by a 15 Amp (minimum) circuit breaker located in the MCC.

.2 A microprocessor based inverter with integral PLC shall control burner functioning. Inverter trips auto-recycle after 25 sec. More than two trips during any 5 minute period will shut off burner, signal an alarm and require a manual reset. Additionally, the inverter shall perform the following functions:

.1 Modulation controller

.2 Boiler circulator time delay relay (off delay)

.3 Flame status and firing rate output

.4 Temperature control, selectable for boiler outlet temperature, header temperature, domestic hot water, boiler outdoor air reset or header outdoor air reset.

.5 Recycle the flame safeguard controller at least once in each 24 hour time period to reset the

.6 Self check circuit of the UV scanner.

.3 Main flame shall be monitored and controlled by an ultra violet scanner. The boiler shall have an CSA approved, commercial-type, microprocessor based (Honeywell 7800) flame safeguard programmer with a flame failure response time of 0.8 seconds maximum. Controller shall have non-volatile diagnostic memory capable of maintaining operational history.

.4 Each boiler shall be provided with all necessary controls, all necessary programming sequences, and all safety interlocks. Each boiler control system shall be properly interlocked with all safeties.

.5 Each boiler control system shall provide timed sequence pre- and post-purge of boiler combustion chamber. The combustion airflow sensor shall monitor and prove the airflow purge.

2.10 Boiler Control Panel

.1 The boiler manufacturer shall provide each boiler with an integral factory prewired control panel. The control panel shall contain at least the following components, all prewired to a numbered terminal strip:

.1 Inverter/Combustion Air Blower Speed Controller

.2 Burner "on-off" switch.

.3 Honeywell RM7800 Series electronic flame safeguard programmer.

.4 Manual control switches for “Local/Remote Enable-Disable”, “Manual Firing Rate Control”, and Local/Remote Modulation”

.5 Diagnostic annunciator indicating lights to signal "Power On", "Demand for Heat", "Low Water Flow", "Low Gas Pressure", "Low Combustion Air", and "Flame Failure".

.6 Air Flow Switch

.7 High Water Temperature Limit

.8 All necessary control switches, pushbuttons, relays, timers, terminal strips, etc.

.9 Interface for remote control and annunciation of boiler status. Control points shall include boiler enable/disable and boiler water supply temperature set-point. Annunciated points shall include boiler on/off, boiler water supply and return temperatures, burner % of full capacity, and general alarm. Analog points shall be through either 4-20 mA or 0-10v signal.

.10 BACnet interface.

2.11 Factory Testing - Hydronic

.1 Each factory "packaged" boiler shall be hydrostatically tested. The boiler manufacturer shall perform a hydrostatic test in the presence of an inspector having a National Board Commission. The inspector shall certify a data report which shall be submitted to the engineer as evidence of ASME compliance.

.2 In addition to the ASME symbol, each boiler shall bear a National Board registration number.

2.12 Venting

.1 Be responsible for provision of the flue vent. Provide venting in compliance with manufacturer’s recommendations.

.2 Condensing and near-condensing boilers will use vents with AL29-4C stainless steel inner liner.

.1 Acceptable Materials:

.1 Ampco, Cleaver Brooks, Metalbestos PS, IPS, Van-Packer DW, Metal-Fab PIC, or equivalent.

Part 3 Execution

3.1 Installation

.1 Make required piping and electric connections including any control wiring between boiler control panel and oil pump starter.

.2 Pipe relief valves and air vent on hot water boilers to floor drain.

.3 Do not deviate from required service and maintenance clearances.

.4 Mount unit level.

.5 Natural gas fired installation to CAN1-B149.1-15, and Provincial safety regulations and bulletins (Technical Safety BC).

.6 Certified gas fitter shall disconnect existing boilers and reconnect new boilers to existing gas line in the boiler room.

.7 Manufacturers representative to provide start-up and burner adjustment service and maintenance and operating instructions. Test reports to be submitted for review and inclusion in maintenance manuals.

.8 Install venting in accordance with manufacturer's recommendations. Take field measurements prior to ordering, and reuse existing venting roof openings.

.9 Coordinate with boiler supplier to confirm if reuse of existing venting sections is acceptable.

.10 Test flue gases, set burner and adjust combustion.

.11 Note phased nature of the project. Maintain water heating operational at all times; ensure the first new boiler is functional before disconnecting the second boiler. Ensure phased startup and testing.

3.2 Boiler Efficiency Test

.1 Test boiler in accordance with the ASME short form test procedure after installation and hook up, but before handling units over to the Departmental Representative. Forward to the Departmental Representative for his approval all appropriate data and calculations. Make any and all alterations as necessary and repeat the tests as often as required until the test results prove that each unit performs as specified. Make all temporary connections, provide all meters, equipment and instruments, provide all engineering personnel required. Forward three (3) copies of the approved test results to the Departmental Representative.

.2 Test and adjust specifically at high fire and low fire, in addition to settings in accordance with manufacturer's recommendation.

3.3 Boiler Shutoff Switch

.1 Provide labeled emergency shut off switches at room exits, per safety code.

END OF SECTION

Part 1 GENERAL

1.1 Related Work

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

1.2 Reference Standards

.1 Do work in accordance with the current edition of the following standards:

.1 Air-Conditioning, Heating and Refrigeration Institute (AHRI)

.1 AHRI-550/590-[15, with Errata], Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle.

.2 ARI 550 (for centrifugal and helical rotary chillers).

.2 ASME Code, Section VIII.

.3 ASTM International

.1 ASTM C547-[07e1], Standard Specification for Mineral Fiber Pipe Insulation.

.4 CSA International

.1 CSA B52-13, Mechanical Refrigeration Code.

.5 Environment Canada/Environmental Protection Services (EPS)

.1 EPS 1/RA/2-[1996], Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

.6 B.C. Refrigeration safety regulations and bulletins (Technical Safety BC).

1.3 Energy Efficiency Performance

.1 Packaged water chillers must meet the minimum coefficient of performance (COP) and integrated part-load value (IPLV) as specified in CSA-C743-02, Section 6, and listed in Table 9 or minimum adjusted COP and non-standard part load value (NPLV) for centrifugal equipment not designed to operate at standard rating conditions in Tables 10 to 15 of CSA-C743-02.

.2 Packaged water chillers must carry a Standards Council of Canada verification mark indicating that the energy performance of the chiller has been verified.

.3 The energy efficiency report (Section 5 of Canada's Energy Efficiency Act) must be submitted by the dealer to the Minister of NRCan before the chiller is imported into Canada or traded interprovincially for the first time.

Part 2 PRODUCTS

2.1 Chillers – Modular, Air Cooled - Scroll

.1 General:

.1 Provide complete air cooled modular chiller package including: compressor(s); evaporator; condenser; condenser fan(s) and motor(s) and motor starter(s), controls, control panel, piping; wiring; refrigeration and oil charge, ready for connection to chilled water circuit, interlocks and electric power source.

.2 Chiller ARI 590 certified.

.3 Chiller factory run tested prior to shipment under simulated operating conditions.

.4 On dual and multiple compressor chillers provide independent dual refrigerant circuits.

.5 Minimum 4 stages – independent refrigerant circuits and compressors.

.6 Chiller will operate year round – include freeze protection.

.2 Casing:

.1 Welded galvanized steel frame with 1.78 and 1.47 mm thick [14 and 16 ga] steel panels and access doors finished in corrosion resistant, enamel paint.

.2 Louvred galvanized steel panel to cover all open ends of the unit.

.3 Compressor:

.1 Single or multiple direct driven scroll compressor(s) of hermetic design operating at 3600 RPM.

.2 Capacity modulation achieved by cycling compressors on and off.

.3 Compressor(s) to include centrifugal oil pump; oil level sight glass; oil charging valve and crankcase heater.

.4 Compressor motor cooled by suction gas.

.4 Evaporator:

.1 Steel shell and seamless finned copper tubes.

.2 Designed, tested and stamped in accordance with ASME Code for Unfired Pressure Vessels for refrigerant side working pressure of 1550 kPa [225 psig] and for water side working pressure of 1035 kPa [150 psig].

.3 Tubes shall be cleanable.

.4 Shell to include drain and vent connection.

.5 Insulation 19 mm [3/4"] thick (K=0.26)).

.6 Heater cables to protect the evaporator to ambients of -29°C [-20°F].

.5 Condenser:

.1 Aluminum fins mechanically bonded to copper tube, pressure tested to 3100 kPa [450 psi].

.2 Direct driven, steel or aluminum propeller type fans, statically and dynamically balanced. Motors with overload protection, permanently lubricated ball bearings.

.3 Head Pressure Control.

.6 Refrigerant Piping:

.1 Refrigerant piping, valves, fittings and related parts to CSA B52 and including:

.1 Thermal expansion valve.

.2 Condenser liquid line solenoid valve.

.3 Combination filter/dryer.

.4 Solenoid stop valves.

.5 Liquid sight glasses, complete with moisture indicator.

.6 High side pressure relief device.

.2 Suction line insulation.

.3 On dual and multiple compressor chillers provide independent dual refrigerant circuits.

.7 Control Panel:

.1 To CEMA standard and to include:

.1 Microcomputer controls to include:

.1 Leaving chilled water control and set point adjustment.

.2 Automatic compressor sequencing.

.3 Condenser fan sequencing.

.4 Load limiting and anti-recycling functions.

.5 Loss of chilled water flow and chiller freezing protection.

.6 Compressor overcurrent, phase loss, phase reversal, under-voltage, over-voltage protection.

.7 Loss of charge, high motor winding protection, high and low refrigerant pressure protection.

.2 Display readouts to include water temperature set-point, operating temperatures and diagnostic readouts.

.3 Field power and control circuit terminal blocks.

.4 Chilled water flow interlock connection.

.5 BACnet interface for connection to building automation system.

.8 Noise Levels:

.1 Noise levels from the air cooled chiller shall not exceed 50 dBA, measured at a distance of 9 m [30 ft] from the nearest face of the unit (dB re. 20 micro Pascal) and 100% loaded.

.2 Provide noise information (per octave bands) in shop drawings.

.9 Accessories:

.1 Automatic capacity control.

.2 Automatic periodic pumpout control.

.3 Low ambient lockout thermostat to shut off the unit when the ambient temperature is below the minimum ambient temperature recommended for proper unit operation.

.4 Compressor Cycle Counter/hour meter.

.5 Control power transformer.

.6 Low Ambient package.

.7 Suction and discharge pressure gauges - One set per refrigeration circuit, field mounted.

.8 Auxiliary isolation ports and valves for servicing.

.9 Communications Interface. BACnet interface: allow also 4-20 mA or 0 - 10 VDC control signal from B.M.S to adjust leaving water temperature set point.

.10 Acceptable Materials:

.1 Multistack, Trane, Florida Heat Pumps, Climacool, or equivalent.

Part 3 EXECUTION

3.1 Chillers - Air Cooled

.1 Unit to be installed as indicated and to manufacturer's recommendations, ensuring adequate clearances for servicing and maintenance.

.2 Arrange piping for easy dismantling to permit tube cleaning.

.3 Provide thermometers on both entering and leaving side of evaporator.

.4 Provide drain valves and vent cocks to each header.

.5 Ensure manufacturers field service representative approves installation and is present to supervise start up and to instruct operators.

.6 The following shall be provided and installed under other Divisions/Sections:

.1 Main fused disconnect - Division

.2 Power wiring from disconnect switch to Chiller connection - Division 26.

.3 Power wiring and disconnect switch to evaporator heat tape - Division 26.

.4 All wiring and conduit between control panel and remote interlocks shall be under Section 23 09 00. External interlock circuits include chilled water pump starter, flow switches, temperature sensor and B.M.S interface.

.5 Wiring for chilled water pump between pump starter and pump shall be provided under Section 23 09 00.

.6 Flow switches on chilled water circuits shall be provided under Section 23 09 13.

.7 Vibration isolation shall be provided under Section 23 05 48.

.8 All unit components, which may cause condensation, shall be insulated on site under Section 23 07 16 unless unit is factory insulated.

END OF SECTION

Part 1 GENERAL

1.1 Related Work

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

1.2 Reference Standards

.1 Do work in accordance with the current edition of the following standards:

.1 Air-Conditioning, Heating and Refrigeration Institute (AHRI)

.1 ARI 550 (for centrifugal and helical rotary chillers).

.2 ASME Code, Section VIII.

.3 ASTM International

.1 ASTM C547-[07e1], Standard Specification for Mineral Fiber Pipe Insulation.

.4 CSA International

.1 CSA B52-13, Mechanical Refrigeration Code.

.5 Environment Canada/Environmental Protection Services (EPS)

.1 EPS 1/RA/2-[1996], Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

.6 B.C. Refrigeration safety regulations and bulletins (Technical Safety BC).

1.3 Energy Efficiency Performance

.1 Packaged cooling units must meet the minimum coefficient of performance (COP) and integrated part-load value (IPLV) as specified in CSA Standards.

1.4 Refrigerant

.1 Environmentally friendly refrigerant.

.2 Refrigerants subject to phaseout are not acceptable.

.3 Complete and submit Halocarbon Inventory forms for each system.

1.5 Warranty

.1 Refrigeration compressors to be warrantied for five [5] years.

Part 2 PRODUCTS

2.1 Fan Coils

.1 General:

.1 Fan coils shall replace existing chilled water-cooled units. Match dimensions of the existing units – connect to existing duct connections. Confirm field measurements.

.2 Refer to drawings and specifications for installation and performance requirements.

.3 Interconnect with respective condensing unit.

.2 Cabinet:

.1 Steel frame and sheet metal cabinet housing fan, coil, drain pan, filters and controls.

.2 Cabinet lined with 12 mm [1/2"] thick acoustic insulation.

.3 Access to all components.

.4 Condensate drain pan.

.3 Fan:

.1 Forward curved fan with adjustable belt speed drive.

.4 Coil:

.1 Aluminum fins bonded to seamless copper tubes.

.5 Refrigerant Circuits:

.1 Refrigerant circuits controlled by factory installed thermal expansion valves.

.6 Filters:

.1 25 mm [1"] thick replaceable media.

.7 Control:

.1 Low voltage terminal board, fan contactor and electric heat control circuit.

.2 Communication kit – interface with respective condensing unit.

.3 Interface with BKS – BACnet based system.

.8 Accessories:

.1 Duct connection collars.

.9 Acceptable Materials:

.1 TCS, Trane, Engineered Air, McQuay, Williams, or equivalent.

2.2 Condensing Units - Air Cooled

.1 VRF condensing unit with controls, each serving its respective fan coil.

.2 System will operate year-round; include freeze protection and low ambient measures.

.2 Casing:

.1 Casing:

.2 Heavy welded steel frame and galvanized steel panels, baked enamel finish.

.3 Removable access panels.

.4 Windshields (for operation to -17.5°C [0°F]).

.3 Compressors:

.1 Scroll and Digital scroll compressors with internal spring isolation.

.2 Centrifugal oil pump.

.3 Crankcase heater.

.4 Refrigerant circuit:

.1 Liquid line filter drier(s).

.2 Liquid line service valve(s) with gauge port.

.3 Suction line service valve(s) with gauge port.

.5 Condenser:

.1 Direct drive propellor fans, vertical discharge.

.2 Fan safety guards.

.3 Condenser coil with aluminum fins bonded to copper tubes.

.6 Controls:

.1 Factory wired in separate enclosure.

.2 24-volt control circuit, control power transformer.

.3 Magnetic contactors.

.4 Overload devices for compressor(s) and fan(s).

.5 Anti-short cycle timer.

.6 Communication kit – interface with respective condensing unit.

.7 Communications Interface. BACnet interface: allow also 4-20 mA or 0 - 10 VDC control signal from B.M.S to adjust room temperature set point.

.7 Acceptable Materials:

.1 TCS, Trane, Engineered Air, McQuay, Williams, or equivalent.

Part 3 EXECUTION

3.1 General

.1 Vibration isolation shall be provided under Section 23 05 48.

.2 All unit components, which may cause condensation, shall be insulated on site under Section 23 07 16 unless unit is factory insulated.

.3 Exterior piping shall be insulated and with aluminum jacket (protection from birds).

3.2 Fan Coils

.1 Maintain service to rooms served operational. Replace one fan coil at a time. Complete a system and make operational before the next fan coil is taken out of service. Do all preparatory work ahead of time before the shutdown of a fan coil, to minimize the duration of the shutdown.

.2 Fan coils shall replace existing chilled water-cooled units. Match dimensions of the existing units – connect to existing duct connections. Confirm field measurements.

.3 Interface with respective condensing unit.

3.3 Condensing Units - Air Cooled

.1 Unit to be installed as indicated and to manufacturer's recommendations, ensuring adequate clearances for servicing and maintenance.

.2 Arrange piping for easy dismantling to permit tube cleaning.

.3 Ensure manufacturers field service representative approves installation and is present to supervise start up and to instruct operators.

.4 The following shall be provided and installed under other Divisions/Sections:

.5 Provide wiring and conduit interconnection with respective fan coil.

.6 Provide B.M.S interface for monitoring.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS & SUMMARY

.1 The General Conditions, Supplements and Amendments shall govern this Section (read in conjunction with Instructions to Tenderers / Bidders). This section covers items common to all Electrical sections and is intended only to supplement the requirements of Division 01.

.2 Reference to “Electrical Divisions” shall mean all sections of Divisions 26.

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

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

.5 The most stringent requirements of this and other electrical sections shall govern.

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

.7 Provide seismic restraints for all required equipment and wiring systems.

.8 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Departmental Representative. Uncrate equipment, move in place and install complete; start-up and test. Include all field assembly of loosely/separately packaged accessories

.9 Coordinate electrical commissioning scope with the Commissioning Manager (prime contractor) and the Departmental Representative. Participate in commissioning activities as a proactive member of the project commissioning team. See Division 01 specifications for project commissioning definitions, acronyms, roles and responsibilities.

1.2 REFERENCES

.1 Install in accordance with CSA C22.1 - 2015 - except where specified otherwise.

.2 Refer to CSA C22.1 Appendix A “Safety Standards for Electrical Equipment” for applicable codes and the related revisions

.3 Refer to CSA C22.1 Pages xxix - xxxii for related ‘Reference Publications’

.4 Refer to Vancouver Building By-Law (VBBL) Table 1.3.1.2 for applicable codes and the related revisions.

.5 Comply with local electrical bulletins and by-laws relating to the Authority Having Jurisdiction (AHJ).

.6 Install overhead and underground systems in accordance with CSA C22.3 No.1 (current adopted edition) - except where specified otherwise.

.7 Preferred Voltage Levels for AC Systems, 0-50,000V in accordance with CAN3-C235 (current adopted edition)

1.3 **DEFINITIONS**

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

1.4 **DESIGN REQUIREMENTS**

.1 Operating voltages: to CAN3-C235 current edition.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 **SUBMITTALS**

.1 Submittals to be in accordance with Division 01.

.2 Product Data: submit WHMIS MSDS in accordance with Division 01 - Sustainable Requirements and Division 02- Hazardous Materials

.3 Single Line Diagram: Provide updated single line electrical diagrams under plexiglass as follows:

.1 Submit full size plot for review prior to installing.

.2 Electrical distribution system: locate in main electrical room.

.4 Fire Alarm Riser: Provide updated fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator. Submit full size plot for review prior to installing.

1.6 **SHOP DRAWINGS:**

.1 Submit shop drawings, product data and samples in accordance with Division 01. The submission shall be reviewed, signed and processed as described in Division 01.

.2 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.

.3 Where applicable, include wiring, line and schematic diagrams. Include wiring drawings or diagrams showing interconnection with work of other Sections.

.4 Content

.1 Shop drawings submitted title sheet.

.2 Data shall be specific and technical.

.3 Identify each piece of equipment.

.4 Information shall include all scheduled data.

.5 Advertising literature will be rejected.

.6 The project and equipment designations shall be identified on each document.

.7 Information shall be given in Imperial units.

.8 The shop drawings/product data shall include:

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

.2 Mounting arrangements.

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

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

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

.5 Format

.1 Shop drawings in electronic format (.pdf) are acceptable.

.2 Black line prints: 8-1/2" x 11" or 11" x 17".

.3 Larger drawings may be submitted on reproducible single sheet media (i.e. not bound) with space for stamps and signatures - master set plus one working copy.

.4 Bill of Quantities for related components, identified by model number, listed on the front cover with item identification numbers.

.6 No. of copies

.1 Provide number of copies indicated in Section Division 01 with a minimum of 2 copies to be retained by the Departmental Representative.

.7 Coordination

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

.8 Keep one copy of shop drawings and product data, on site, available for reference.

.9 Quality Control: in accordance with Division 01 - Quality Control

.1 Provide CSA certified equipment and material. Where CSA certified equipment and/or material is not available, submit such equipment and/or material to the authority having jurisdiction for special approval before delivery to site.

.2 Submit test results of installed electrical systems and instrumentation.

.3 Submit, upon completion of Work, the electrical “load balance” report.

.10 Permits and Fees:

.1 Submit to Electrical Inspection Department, local fire authorities and supply authority the necessary number of drawings and specifications for examination and approval prior to commencement of work. Obtain all required permits and pay all fees.

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

1.7 **QUALITY ASSURANCE**

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

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial and/or Territorial Act respecting manpower vocational training and qualification.

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.3 Site Meetings: in accordance with Section 01 01 50 General Instructions (CSC).

.1 Site Meetings: as part of Manufacturer's Field Services: schedule site visits, to review Work, at stages listed below:

.1 At time of initial shop drawing submission to confirm any existing conditions and to coordinate with the project schedule and any cross-discipline requirements.

.2 After delivery and storage of products, and when preparatory Work is complete but before installation begins.

.3 During progress of Work at key schedule points as determined.

.4 At commissioning.

.5 Upon completion of Work, after cleaning is carried out.

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements (CSC).

1.8 **DELIVERY, STORAGE AND HANDLING**

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 4 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and/or recycling in accordance with Section 01 Division 01 Construction/Demolition Waste Management and Disposal.

1.9 **SYSTEM START-UP**

.1 Refer to Division 01, and as follows.

.2 Instruct Departmental Representative and operating personnel in the operation, care and maintenance of equipment.

.3 Arrange and pay for services of manufacturer's factory service Departmental Representative to supervise start-up of installation, check, adjust, balance and calibrate components, where required in these specifications.

.4 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.

1.10 **OPERATING INSTRUCTIONS**

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.3 Safety precautions.

.4 Procedures to be followed in event of equipment failure.

.5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.11 **WASTE MANAGEMENT AND DISPOSAL**

.1 Separate and recycle waste materials in accordance with Section 01 74 19 – Waste Management and Disposal.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

1.12 **ASBESTOS REMOVAL**

.1 Refer to specification Divisions 01 and 02 for procedures, removal and disposal of asbestos.

.2 If during renovations / demolition, asbestos is discovered (or material suspected to be asbestos), all work in that area shall immediately cease and the General Contractor advised. The General Contractor shall take immediate appropriate action to verify presence of friable asbestos and be responsible for the removal of all friable asbestos.

.3 This division will not be entitled to a claim for any delays resulting from the investigation of or removal of asbestos.

1.13 **DRAWINGS AND MEASUREMENTS**

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

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

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

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

1.14 **PROJECT COORDINATION**

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

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

.3 Work out jointly all interference problems on the site and coordinate all work before fabricating, or installing any material or equipment. Where necessary, produce interference/coordination drawings showing exact locations of electrical systems or equipment within service areas, shafts and the ceiling space. Distribute copies of the final interference/coordination drawings to the Departmental Representative and all affected parties.

.4 Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Departmental Representative of space problems before installing any material or equipment. Demonstrate to the Departmental Representative on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required.

1.15 **PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION**

.1 Leave clear spaces designated for future equipment or building expansion where indicated. Plan for the installation under this contract and ensure clear accessible, unhindered access to the space is allowed for.

.2 Were contract documents don't clearly indicate the future expansion requirements, but known services are required, provide written "request for information" to the Departmental Representative before making assumptions as to intent.

1.16 **SPRINKLER PROOF REQUIREMENTS**

.1 All equipment and wiring systems shall be sprinkler-proof standard where sprinkler fire protection systems are installed.

.2 In rooms where electrical equipment is installed surface mounted, electrical equipment contained in these rooms to be protected by non-

combustible driphoods, shields, and gasketed doors as applicable to inhibit water ingress into electrical equipment. Exposed conduits connected to equipment to utilize watertight connectors. Top entry to be avoided where possible

.3 In particular, all unit substations, transformers, switchgear, motor control and panelboard shop drawings shall be certified 'sprinkler proof' design.

1.17 **EQUIPMENT RESTRAINT**

.1 Related Section: 26 05 05 Seismic Restraints.

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

1.18 **REUSED EQUIPMENT**

.1 Where existing equipment is being relocated and re-used, check and report on the condition to the Departmental Representative before reinstallation. Protect and carefully store equipment designated for reuse.

1.19 **PHASED CONSTRUCTION**

.1 See Architectural specifications and drawings for construction phasing. Make all allowances to phase the work in accordance with the project phasing.

.2 All existing services and the existing building(s) must be maintained in operation. Provide and install temporary services as required.

.3 All trades in this Division shall make allowance for the implications of having to totally complete all work in the new addition before proceeding with work in the existing building.

1.20 **SEQUENCE OF WORK**

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

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

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

.4 All trades in this Division shall make allowance for the implications of having to totally complete all work in the new addition before proceeding with work in the existing building.

1.21 **BUILDING OPERATION DURING CONSTRUCTION**

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

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

1.22 **EXISTING SERVICES**

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

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

.3 Shutdowns, to permit connections, to be coordinated with the maintenance staff.

.4 In order to maintain existing services in operation, temporary relocations and wiring may be required.

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

.6 The interruption of utility services to permit tie-ins shall be arranged through the Departmental Representative's representative. Application must be received in writing at least seven (7) calendar days prior to the date required for the shutdown. Service shutdowns shall only be carried out by the Departmental Representative's maintenance personnel and will normally be scheduled to occur during evenings or weekends. The Departmental Representative reserves the right to withhold permission for a reasonable period with respect to any shutdown, if the shutting-off of a service interferes with essential building operations.

1.23 **SALVAGE**

.1 All conduit, wiring and equipment which becomes redundant and is no longer required due to the work in this Contract shall be completely removed.

.2 All existing items which need to be removed, and which have a reasonable salvage value, shall be carefully removed and handed over to the Departmental Representative. Handing over to the Departmental Representative includes moving to Departmental Representative's designated storage place on site. These items shall not become the property of the Contractor. Obtain a written receipt from the Departmental Representative detailing each of the items handed over.

.3 Remove all redundant material not required by the Departmental Representative from the site.

1.24 **WARRANTY**

.1 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the Division 01.

.2 Take note of any extended warranties specified.

.3 Furnish a written warranty stating that all work executed under this Division will be free from defects of material and workmanship for a period of one (1) year from the date of substantial performance.

.4 Promptly investigate any electrical or control malfunction, and repair or replace all such defective work and all other damages thereby which becomes defective during the time of the warranty.

1.25 **EXAMINATION**

.1 Examine the documents for details of work included. Obtain a written clarification in the event of conflict within the specification, between the specification and the drawing, or in the drawing. Obtain written clarification from the Departmental Representative if work affecting the installation is not clear. Where this is not done in advance, allow in the tender sum for providing the more costly alternative.

1.26 **RESPONSIBILITIES**

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

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

.3 Protect equipment and material from the weather, moisture, dust and physical damage.

.4 Cover equipment openings and open ends of conduit, piping and pull boxes as work progresses. Failure to do so will result in the Trade being required to adequately clean or replace materials and equipment at no extra cost to the Departmental Representative.

.5 Protect all existing services encountered. Obtain instructions from the Departmental Representative when existing services require relocation or modification.

.6 Refinish damaged or marred factory finish to factory finish.

.7 The specifications and drawings form an integral part of the Contract Documents. Neither the drawings nor the specifications shall be used alone. Work omitted from the drawings but mentioned or reasonably implied in the specifications, vice versa, shall be considered as properly and sufficiently specified and shall be provided. Misinterpretation of any requirement of either plans or specifications shall not relieve this Contractor of the responsibility of properly completing his trade to the approval of the Departmental Representative.

1.27 **STANDARD OF ACCEPTANCE**

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

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

.3 Where other than the first named or the underlined manufacturer or scheduled/specified manufacturer is selected or approved, include for the cost of any resulting work (both under this Division and other Divisions) and any necessary redesign of installation or structure. Submit redesign drawings for review with Shop Drawings. Maintain installation, access and servicing clearances. Equipment/materials shall not exceed the available space limitations. Redesign drawings shall be to scale and of a standard equal to the Project Drawings.

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

1.28 **ADDITION OF ACCEPTABLE MANUFACTURERS**

.1 Material/products considered to satisfy the specification, but of a manufacturer other than those named may be submitted to the Departmental Representative for consideration not later than five (5)

working days prior to closing of tender or of bid depository subtrade tender whichever is earlier.

.2 Alternate approvals will be given by written addendum only. No other substitution will be permitted after closing of tenders.

.3 Alternate approvals granted before the closing of tenders will be limited to a manufacturer's system and/or series only. This limited approval will not preclude substitute equipment/material from complying with specific features included with equipment/material specified. Determine that the alternate product meets the specification intent before basing a tender on the product

.4 Where alternate equipment/materials are selected, allow for effects on other parts of the work of this Trade and other Trades. Where substantial changes in arrangement are required, submit shop drawings of the proposed changes with Plan and Section views and show effects on work of other Trades. Alternate equipment/materials shall not exceed the available space limitations. Maintain installation, access and servicing clearances. No extra will be allowed due to the use of alternate equipment/materials.

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

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

1.29 **EQUIPMENT LIST**

.1 Submit a completed Equipment List, showing the make of equipment and material included in the Tender, including the names of the subtrades, 10 days after the award of the Contract**. Form EF110** in Section 26 30 00 shall be used for this purpose.

.2 The equipment list shall be a full list of materials or systems intended for installation.

1.30 **PROGRESS CLAIM AND CHANGEORDER BREAKDOWNS**

.1 Ten (10) days after the award of contract, submit price breakdowns on photocopies of the Price Breakdown **Form EF112** included in Section 26 30 00.

.2 In particular cases more detail may be necessary to properly assess a change order or progress claims. This additional information could include all suppliers and all sub-contractors when requested by the Departmental Representative. Provide details for each section of the electrical work listed for each separate electrical change order item exceeding $5,000.00.

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

.4 Progress claims will not be certified nor payment made beyond 90% of the overall Electrical contract until commissioning and verification of the systems are complete. This procedure is to allow for any necessary deficiency holdbacks on items which do not become apparent until the systems are commissioned.

1.31 **PROJECT CLOSE-OUT REQUIREMENTS**

.1 Refer to detailed specifications in each section for detailed requirements. Also refer to Specification Section 26 30 00 Form EF-142 for list of required substantial completion submissions. Record drawings to be submitted to Departmental Representative and all life safety systems must be operational, verified and tested and demonstrated to Departmental Representative prior to issuance of Schedule C.

1.32 **SUBSTANTIAL PERFORMANCE REQUIREMENTS**

.1 Before the Departmental Representative is requested to make an inspection for substantial performance of the work:

.1 Commission all systems and prove out all components, interlocks and safety devices.

.2 Submit a letter certifying that all work is complete for the intended use, operational, clean and all required submissions have been completed. **Form EF143** in Section 26 30 00 should be used for this purpose.

.3 A complete list of incomplete or deficient items shall be provided. If, in the opinion of the Departmental Representative, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.

.2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:

.1 All reported deficiencies have been corrected.

.2 Operating and Maintenance Manuals completed.

.3 "As Built" Record Drawing ready for review.

.4 Systems Commissioning has been completed and has been verified by Departmental Representative.

.5 All demonstrations to the Departmental Representative have been completed.

.6 All documents required on **Form EF142** in Section 26 30 00 have been submitted.

.3 Departmental Representatives Letters of Assurance will not be issued until the following requirements have been met:

.1 All items listed in .1 above have been completed or addressed.

.2 Certificate of Penetrations through separations (**Form EF130**).

.3 Provincial or City Electrical Inspection - Certificate of inspection.

.4 Seismic Engineers letter of Assurance and final inspection report.

.5 Certificate of Substantial Performance (**Form EF143**).

.6 Signed off copy of Departmental Representatives final inspection report.

.7 Fire alarm verification including sound pressure (dB) measurement test results.

1.33 **DEFICIENCY HOLDBACKS AND DEFICIENCY INSPECTIONS**

.1 Work under this Division which is still outstanding when substantial performance is certified will be considered deficient and a sum equal to at least twice the estimated cost of completing that work will be held back.

.2 It is expected that outstanding work will be completed in an expeditious manner and the entire holdback sum will be retained until the requirements for Total Performance of Division 26 (electrical) work have been met and verified.

Part 2 Products

2.1 **SUSTAINABLE REQUIREMENTS**

.1 Materials and products in accordance with Division 01.

.2 Do verification requirements in accordance with Division 01.

2.2 **MATERIALS AND EQUIPMENT**

.1 Provide materials and equipment in accordance with Division 01 and as follows.

.2 Material and equipment to be CSA certified. Where CSA certified material or equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval.

.3 Where equipment or materials are specified by technical description only, they are to be of the best commercial quality available for the intended purpose.

.4 Factory assemble control panels and component assemblies.

2.3 **ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

.1 Provide all power and control wiring, conduit, wire, fittings, disconnect switches, motor starters, for all mechanical equipment unless otherwise specified.

.2 Ground all motors to conduit system with separate grounding conductor in flexible conduit or bonding conductor in the flexible conduit.

.3 Connections shall be made with watertight flexible conduit with watertight connectors.

.4 Control wiring and conduit standards are specified in the Electrical Divisions. Refer to Mechanical Divisions for scope of work and particular details.

2.4 **WARNING SIGNS**

.1 Provide warning signs, as specified or to meet the requirements of Inspection Department, Authority having Jurisdiction, Departmental Representative and Architect.

.2 Use decal signs, minimum 7" x 10" size

2.5 **WIRING TERMINATIONS**

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

2.6 **EQUIPMENT IDENTIFICATION**

.1 Identify all electrical equipment including but not limited to starters, disconnects, remote ballasts and controls with nameplates and labels as follows:

.2 Nameplates:

.1 Lamicoid 3 mm [0.125"] thick plastic engraving sheet, white face, black core, self adhesive unless specified otherwise. Provide white face, red core for all essential distribution equipment.

.2 Nameplate Sizes:

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

.3 Typical Labelling:

.1 Panelboard & CDP – 5 lines

.1 Line 1 – eg Conditional/Vital – Size 4 lettering

.2 Line 2 – Panel/CDP designation – Size 4 lettering

.3 Line 3 – eg 225A, 120/208V, 3 phase 4W – Size 2 lettering

.4 Line 4 – Feeder: eg 4#3 – 35mm C – Size 2 lettering

.5 Line 5 – Origin eg: Main Elect. Room – Size 2 lettering

.2 Distribution Circuit Breakers – 4 lines

.1 Line 1 – Conditional/Vital – Size 4 lettering

.2 Line 2 – Main Circuit Breaker – Size 4 lettering

.3 Line 3 – Feeder: eg 4#3 – Size 2 lettering

.4 Line 4 – Origin: eg K1 Sub-station – Size 2 lettering

.3 Label colours unless otherwise indicated:

.1 120/208V labels: white letters on black base.

.2 347/600V labels: Black letters on white base.

.3 Standby/Emergency Power: white letters on red base.

.4 Wording on nameplates to be approved prior to manufacture.

.5 Allow for average of twenty-five (25) letters per nameplate.

.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

.8 Transformers: indicate capacity, primary and secondary voltages.

.3 Labels:

.1 Identify each outlet, starter, disconnect and all items of fixed equipment with the appropriate panel and circuit number origin by means of a small but good quality vinyl, self-laminating label such as T & B E-Z Code WSL, Dymo Letratag or Brother P-Touch equivalent printable markers. Embossed Dymo or any labels with edges and corners that are prone to lift will be rejected. Confirm location of labels with Departmental Representative before installing. Circuit number to agree with Record Drawings.

.4 Provide plastic covered panel directory with circuits and areas served typed in, and mounted on inside of door. Directory to conform to Record Drawings.

2.7 **WIRING IDENTIFICATION**

.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1.

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

system.

2.8 **CONDUIT, CABLE AND PULLBOX IDENTIFICATION**

.1 Colour code conduits, metallic sheathed cables, pullboxes and junction boxes.

.2 Code with 25 mm plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor and at 15 m intervals.

.3 Colour coding to be as follows unless otherwise specified:

SYSTEM	MAJOR BAND	MINOR BAND	CHARACTERS
347/600V Normal	Dark Blue		
347/600V Emergency	Dark Blue	Red	
120/208V Normal	Light Blue		
120/208V Emergency	Light Blue	Red	
Ground	Dark Green		GR
Fire Alarm	Red		FA
Computer/Data	Light Green		COM
Telephone	Light Green	Black	TEL
General Intercom	Light Green	Yellow	IC
Low Level Paging	Light Green	White	PA
Commercial TV	Dark Brown		TV
AV/TV Systems	Light Brown		AV/TV
Security Systems	Purple		SEC
Building Alarm	Purple	White	BA
CCTV	Purple	Yellow	CCTV
Door Intercom	Purple	White	DI
Door Lock Release	Purple	Black	ED
Master Clock System	Yellow		CS
BAS (Digital)	White	Green	BCD
BAS (110V)	White	Black	BCH
BAS (LV)	White	Blue	BCL
PLC (Digital)	White	Brown	PLC
Low Voltage Control	White	Yellow	LVC

2.9 **FINISHES**

.1 Shop finish metal enclosure surfaces by removal of rust and scale,

cleaning, application of rust resistant primer inside and outside and at least two coats of finish enamel.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original finish.

.3 Clean and prime paint exposed hangers, racks, fastenings to prevent rusting. Finish painting shall be provided by Division 09.

.4 Paint outdoor electrical equipment "equipment green" finish.

.5 Paint indoor switchgear and distribution enclosures light gray unless otherwise indicated in particular specification sections for specialised or emergency power equipment.

2.10 **ACCESS PANELS (DOORS)**

.1 Unless otherwise noted, access doors shall be minimum: 450mmx450mm [18"x18"] for body entry; 300mmx300mm [12”x 12”] for hand entry.

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

.3 Minimum Requirements:

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

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

.1 Acceptable Product: Acudor PS-5030, or equivalent.

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

.1 Acceptable Product: Acudor UF-5000, or equivalent.

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

.1 Acceptable Product: Acudor PS-5030 stainless, or equivalent.

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

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

.6 Feature wall construction: Recessed wall type that is selected to complement and conform to the architectural module, treatment,

or panelling. The size shall conform to adjacent finishes.

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

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

2.11 **ANCHOR BOLTS AND TEMPLATES**

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

2.12 **FASTENING TO BUILDING STRUCTURE**

.1 General:

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

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

.2 Types:

.1 Cast-in-place type:

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

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

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

.2 Drilled, mechanical expansion type:

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

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

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

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

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

.3 Drilled, adhesive type:

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

.2 Hilti HY150, or equivalent, consisting of anchor rod with a 2-part adhesive system.

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

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

.3 Note:

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

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

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

2.13 **EQUIPMENT SUPPORTS**

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

.2 Lay out concrete bases and curbs required under Electrical Divisions. Coordinate with Concrete Divisions.

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

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

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

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

2.14 **MISCELLANEOUS METAL**

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

.1 Support of equipment.

.2 Hanging, support, anchoring, guiding and relative work as it applies to wiring raceways and electrical equipment.

.3 Earthquake restraint devices - refer also to "Seismic Restraint" sections

.4 Bridle rings - secure to structure or steel supports.

.2 All steel work shall be prime and undercoat painted ready for finish under the related Division.

2.15 **MAINTENANCE MATERIALS AND CABINET**

.1 Provide maintenance materials in accordance with Division 01 and specified in appropriate Sections.

.2 Refer to Specification Section 26 30 00 Electrical **Form EF140** "Items to be handed to the Departmental Representative". Obtain the Building Departmental Representatives representative sign off. Use **Form EF 140** for this purpose.

.3 Provide a finished painted sheet steel "spare equipment cabinet". Cabinet to have a continuous hinge and complete with shelves and hasp to suit padlock. Minimum size 600 [24"] x 900 [36"] x 200 [8"] deep. Mount on wall in the Electrical Room. Provide a plastic covered typewritten list of spare parts and affix to the inside of the door.

2.16 **OPERATION AND MAINTENANCE DATA**

.1 Provide operation and maintenance data for incorporation into maintenance manual specified in Division 01 and as follows.

.2 Include in operations and maintenance data:

.1 Details of design elements, construction features, component function and maintenance requirements, to permit effective 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.

.4 Names and addresses of local suppliers for items included in maintenance manuals.

.3 Include in the manual the following major sections:

.1 Title page (in plastic cover).

.2 Comprehensive description of the operation of the systems, including the function of each item of equipment within the system.

.3 Detailed instructions for the normal maintenance of all systems and equipment installed including procedures and frequency of operational checks and service and troubleshooting instructions.

.4 Local source of supply for each item of equipment.

.5 Wiring and control diagrams.

.6 Spare parts list.

.7 Copies of guarantees and certificates.

.8 Manufacturer's maintenance brochures and shop drawings.

.4 The manual information shall be bound in a three “D-ring” hard back reinforced vinyl covered ("bar lock" post type where more than 50mm [2”] rings required) binder c/w index tab separators to divide the different sections. The binder cover shall be black with white lettering. Printing of the binder cover shall be completed before the binder is manufactured and the wording shall be approved by the Departmental Representative before printing.

.5 Submit a draft copy to the Departmental Representative for review 30 days prior to start up of the systems and equipment.

.6 Submit three copies in the final approved form.

.7 Submit a compact disk or USB memory stick containing electronic .pdf copies of all final information contained in the manual.

2.17 **PROJECT RECORD DRAWINGS**

.1 Provide project record documents as specified in Division 01 as further called for in this Division.

.2 During the construction period, keep on site a clean set of drawings marked up to reflect the "As-Built" state, for examination by the Departmental Representative on a regular basis. Include elevations and detailed locations of buried services, empty conduit systems and junction and pull boxes.

.3 At the time of "substantial performance" obtain a set of CAD files from the Departmental Representative. The Electrical Division shall include all associated costs to modify and complete the CAD Record (As-built) Drawings including retaining the services of a qualified CAD draftsperson to transfer all changes to amend the CAD files in the latest version of AutoCAD. Include all revisions and change orders.

.4 Submit the four sets of "Record Drawing" CAD files and four sets of plots to the Departmental Representative prior to Total Performance of the contract.

.5 Note: The Contractor will be required to sign a standard Contractor agreement entitled "Authorization to Use CAD drawing files". The agreement restricts the use of the CAD files to the purpose of "as-built" only and determines the editing procedures.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

.1 Ensure manufacturers nameplates and CSA labels to be visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit and protruding 50 mm [2”].

.2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

.3 Install roof jacks where conduit and cables penetrate roofs. Apply sealant after installation.

.4 All cables and conduits to be installed concealed in finished areas.

3.4 LOCATION OF OUTLETS

.1 Do not install outlets back-to-back or in the same stud space in wall; allow minimum 400mm [16”] horizontal clearance between boxes.

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm [10”- 0”] and information is given before installation.

.3 Locate light switches on strike side of doors unless otherwise indicated.

.4 Locate light switches on latch side of doors.

.5 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not indicated verify before proceeding with installation. Confirm the height of devices in handicapped facilities before installation.

.3 Refer to details on drawings.

.4 In the absence of a drawing detail or drawing note, use the following:

Device	**Height**		**Comment**
Local switches	1200	[48"]	
Wall receptacles/data	450	[18"]	General
Wall receptacles/data	200	[8"]	Above top of continuous baseboard heater
Wall receptacles/data	175	[7"]	Above top of counters or counter splash backs – coordinate with Architectural detail
Wall receptacles/data	900	[36"]	In mechanical rooms
Panelboards	2000	[80"]	Panelboards: as required by Code or as indicated.
Wall mtd telephone	1500	[60"]	
Card Readers	1200	[48"]	Confirm before installation
Fire alarm stations	1350	[54"]	ULC S524 requires not less than 1200mm or more than1400mm.
Fire alarm bells/audio	2200	[88"]	ULC S524 requires not less than 1800mm to centre. In any event not closer than 50mm to the ceiling
Fire alarm visual devices	2000	[80"]	ULC S524 requires not more than 2000mm to centre. In any event not closer than 150mm to the ceiling
Fire alarm Annunciator	1800 Top	[72"]	ULC S524 requires not more than 1800mm above finished floor.
End of line resistors	1800	[72"]	
Television outlets			As receptacles – coordinate with equipment location

Device	Height		Comment
Wall mounted speakers & clocks	2100	[84”]	Coordinate with equipment location
Door bell pushbuttons	1500	[60”]	Coordinate with location
Emergency Lighting (wall mounted)			150mm below ceiling or 4800mm max.

3.6 **COORDINATION OF PROTECTIVE DEVICES**

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to the required values and settings to provide a fully coordinated system.

3.7 **FIELD QUALITY CONTROL**

.1 Load and Balance:

.1 Measure voltage and phase & neutral currents to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase and neutral currents to dry-core transformers and motor control centres, operating under normal load,

.3 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.2 Conduct and pay for the following tests:

.1 Power distribution system including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its controls.

.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.5 Systems: fire alarm system and communications.

.6 Main ground resistance (at all grounding locations).

.7 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 Provide Departmental Representative with at least one week's notice prior to testing.

.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.

.2 Furnish manufacturer's certificate or letter conforming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.3 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.

.4 Schedule site visits to review work.

.6 Reports:

.1 Provide written reports in a timely manner upon completion of the testing and load balance. Indicate test hour and date.

3.8 **CLEANING**

.1 Do final cleaning in accordance with Division 01.

.2 At time of final cleaning, clean lighting reflectors, lenses and other lighting surfaces that have been exposed to construction dust and dirt.

.3 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.4 Clean and prime paint exposed non-galvanised hangers, racks, fastenings to prevent rusting. Coordinate finish painting with Division 09.

3.9 **WORKMANSHIP**

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

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

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

3.10 **PROTECTION OF WORK**

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

.2 Mask machined surfaces. Secure covers over equipment openings and open ends of equipment and conduit, as the installation work progresses.

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

.4 Refinish damaged or marred factory finish.

3.11 **PROTECTION OF ELECTRICAL EQUIPMENT**

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark live parts, e.g. "LIVE 120 VOLTS".

.3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.

3.12 **CONCEALMENT**

.1 Conceal wiring and conduit in partitions, walls, crawlspaces and ceiling spaces, unless otherwise noted.

.2 Do not install wiring and conduit on outside walls or on roofs unless specifically directed.

3.13 **SERVICE PENETRATIONS IN RATED FIRE SEPARATIONS**

.1 All cabling, wiring, conduits, cable trays, etc. passing through rated fire separations shall be smoke and fire stopped to a ULC or cUL tested assembly system, in accordance with CAN4-S115-95, that meets the requirements of the building code in effect.

.2 The scope includes new services which pass through existing rated separations and also all existing services which pass through a new rated separation or existing separations whose rating has been upgraded.

.3 Fire resistance rating of installed firestopping assembly shall not be less than fire resistance rating of surrounding assembly indicated on Architectural drawings. Where this is not indicated assume a minimum of one hour for walls and two hours for floors.

.4 Install firestopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions. The Applicator shall be approved, licensed and supervised by the manufacturer in the installation of firestopping and are to follow the requirements of a rated system as detailed above.

.5 Contractors are expected to submit system information detailing firestopping product, backing, penetrant, penetrated assembly, Fire (F) and Temperature (T) rating, and ULC or cUL system number.

.6 Provide fire stopping material and system information in the maintenance manuals and via labels at major penetrations that are likely to be re-penetrated.

.7 All penetrations are to be firestopped using EZ Path System (Specified Technologies Inc - STI) or approved equal.

.8 Allow openings for 100% capacity of raceway or 200% capacity of J-hooks.

.9 Provide split systems where existing cables are involved.

.10 Provide Firestopping approval certificate in including a Building Code / By-Law Schedule B & C-B signed by a BC registered Professional Engineer. Submit a letter certifying that all work is complete and in accordance with this specification. Electrical Form EF130 in Section 26 06 02 should be used for this purpose.

3.14 **SERVICE PENETRATIONS IN NON-RATED SEPARATIONS**

.1 All cabling, wiring, conduits, cable trays, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with caulking or silicon sealant to prevent the passage of smoke and/or transmission of sound.

3.15 **CONDUIT SLEEVES**

.1 Provide conduit sleeves for all conduit and wiring passing through rated walls and floors. Sleeves to be concentric with conduit or wiring.

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

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

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

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

.6 Sleeve Size: 12 mm [1/2"] clearance all around, between sleeve and conduit or wiring.

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

.8 Packing of Sleeves:

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

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

3.16 **ACCESSIBILITY AND ACCESS PANELS**

.1 Install all equipment, controls and junction boxes so as to be readily accessible for future modification, adjustment, operation and maintenance as appropriate.

.2 Provide access panels where required in building surfaces. Do not locate access panels in panelled or special finish walls, without prior approval of the Departmental Representative.

.3 Access panels in U.L.C. fire separations and fire walls shall have a compatible fire rating and U.L.C. label. Acquire approval in writing from the local fire authority if required.

.4 Access panels shall be painted with a primer coat if applicable and then with a finish coat, colour and type to the Departmental Representative's approval.

.5 Locate equipment and junction boxes in service areas wherever possible.

3.17 **EQUIPMENT INSTALLATION**

.1 Provide means of access for servicing equipment.

.2 CSA identification and equipment labels to be clearly visible after installation.

3.18 **CUTTING, PATCHING, DIGGING, CANNING, CORING & CONCRETE**

.1 Lay out all cutting, patching, digging, canning and coring required to accommodate the electrical services. Coordinate with other Divisions. The performance of actual cutting, patching, digging, canning and coring is specified under other Divisions.

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

.3 Be responsible for correct location and sizing of all openings required under Electrical Divisions, including piped sleeves.

.4 Verify the location of existing and planned service runs and structural components within concrete floor and walls prior to core drilling and/or cutting. Repairs to existing services and structural components damaged as a result of core drilling and cutting is included in this section of the work.

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

.6 Openings in Concrete:

.1 Be responsible for the layout of all openings in concrete, where openings are not left ready under previous contract.

.2 All openings shall be core drilled or diamond saw cut.

.3 Refer to structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls.

.4 Refer to structural drawings for locations of steel reinforcing.

.5 Be responsible for repairing any damage to steel reinforcing.

.7 Openings in building surfaces other than concrete:

.1 Lay out all openings required.

.8 Poured concrete for duct encasements, pole bases, transformer pads and housekeeping pads shall be provided by other Divisions, coordinated and supervised by the Electrical Divisions.

.9 Precast concrete items such as transformer pad bases, pull boxes and light pole bases to be provided and installed by the Electrical Divisions unless otherwise specified.

.10 Excavation and backfilling will be provided by other Divisions. This Division to superintend the work and provide all layouts and parameters.

3.19 **PAINTING**

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

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

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

.4 Coordinate with Division 09.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

.2 Division 01 Operation and Maintenance Manuals.

.3 Section 26 05 00 Common Work Results

.4 Section 26 08 00, Commissioning of Electrical Equipment Systems and Instruction.

1.2 SCOPE

.1 Electrical operations and maintenance manuals (hereinafter referred to as O&M manuals) shall be prepared by a firm specializing in this type of work.

.2 Specialty firm to be responsible for:

.1 The supply and preparation of four sets of O&M manual binders and tabs as specified in the index below.

.2 The preparation of all written system descriptions and schematics (neatly drafted) for each tab section identified as article 1.4. Format as directed by the Departmental Representative, utilizing proportional typewritten format, with schematics in appendices at the end of each section. System description shall include an overview of basic design philosophy, description of future expansion capability, general construction of components, electrical characteristics not readily deduced from the contract documents, basic system configuration and interfaces with other systems existing or new.

.3 Securing and assembling all necessary literature describing operational and maintenance procedures for all equipment into the O&M manual binders, including Preventative Maintenance data as described below. Preventative maintenance data and maintenance suggestions to be compiled in tabular format in applicable section to provide a comprehensive overview of maintenance procedures.

.4 Preparing in coordination with Electrical Divisions and equipment manufacturer's technical specialist, scheduled maintenance sheets and check lists. Scheduled maintenance sheets shall include safety in maintenance data plus detailed daily, monthly and yearly scheduled maintenance information. Format as directed by the Departmental Representative.

.5 Preparation of safety in maintenance suggestions and procedures.

.6 Summarized daily, monthly and yearly maintenance charts.

.7 Plastic sheet protectors for all drawings larger than 210 mm × 275 mm. Locate drawing title block on lower right hand corner.

.3 Division 26 shall be responsible for:

.1 Supplying four copies of all information as described below:

.1 Final shop drawings.

.2 All wiring diagrams.

.3 List of all major trades, sub-trades and suppliers including names of equipment supplied and by whom, addresses, phone numbers, facsimile numbers and contact persons.

.4 Obtaining all data necessary to compile a complete comprehensive Preventative Maintenance program. Data gathered shall be neatly handwritten on forms provided by the Departmental Representative. Data to be collected for all systems described in the index below.

.5 Spare/replacement parts lists for all of the above. Copies of the electrical contractor's data collection sheets available during tendering period when requested.

.6 Test results as outlined in other sections of this specification.

1.3 ELECTRONIC FORMAT

.1 In addition to the specified hardcopy, provide an electronic copy in pdf format. Electronic copy to be produced in the latest version of Acrobat and stored in a compact disk (CD) or USB drive.

.2 CD or USB drive to be reproducible by Departmental Representative as required to carry out his duties.

.3 Electronic copy to consist of a single pdf file divided into chapters to allow a quick and easy access to the different sections of the manual.

.4 All log sheet, maintenance tables preventative maintenance sheets intended to be completed by the Departmental Representative are to be completely interactive allowing the Departmental Representative to complete all pertinent information and save, print or modify these forms as required.

.5 Provide a proposed layout to the construction for approval prior to the construction.

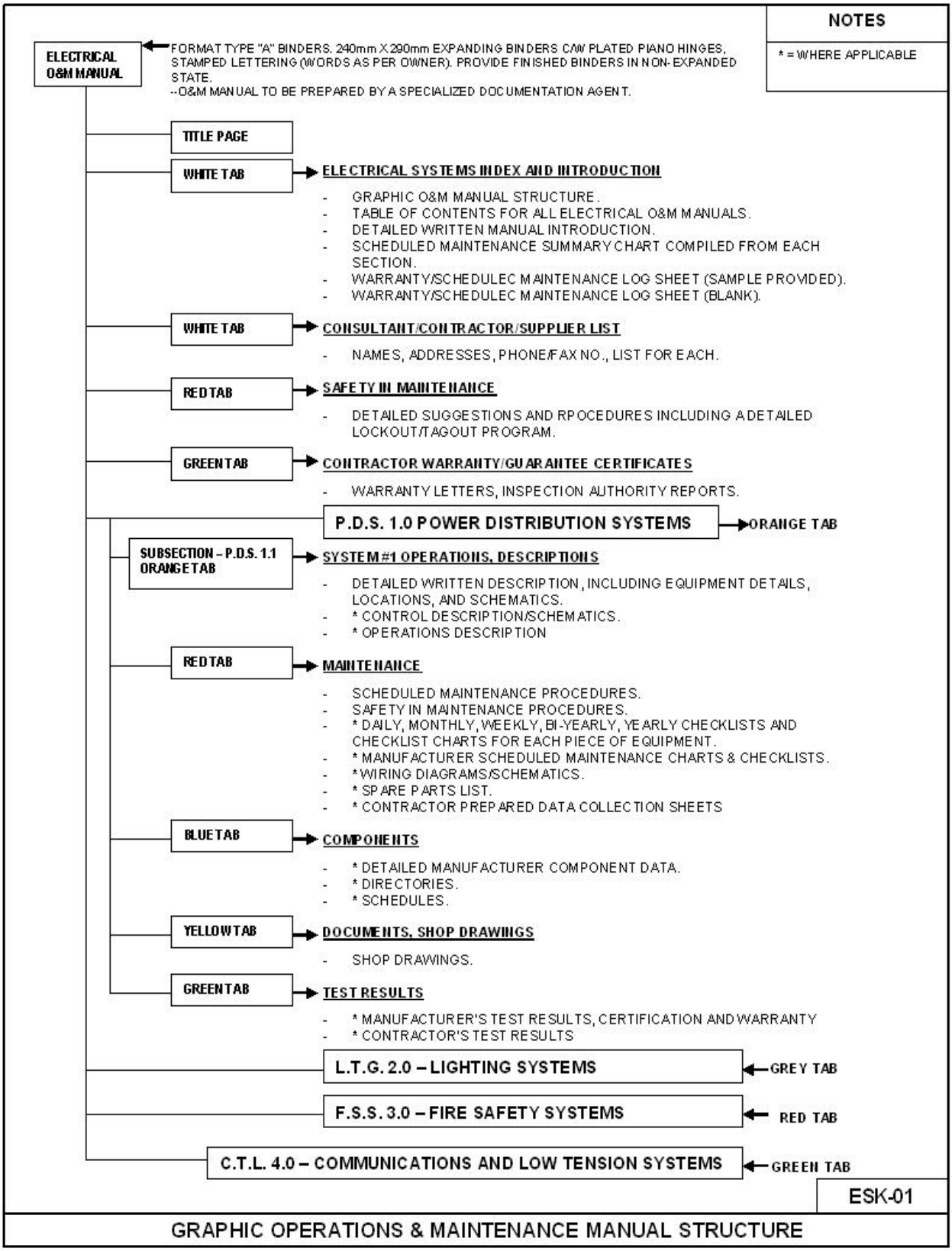
.6 Electrical contractor to submit complete system description and schematics by 50% complete stage of construction. O&M manuals to be submitted to the Departmental Representative 90% complete three (3) months prior to substantial completion inspection.

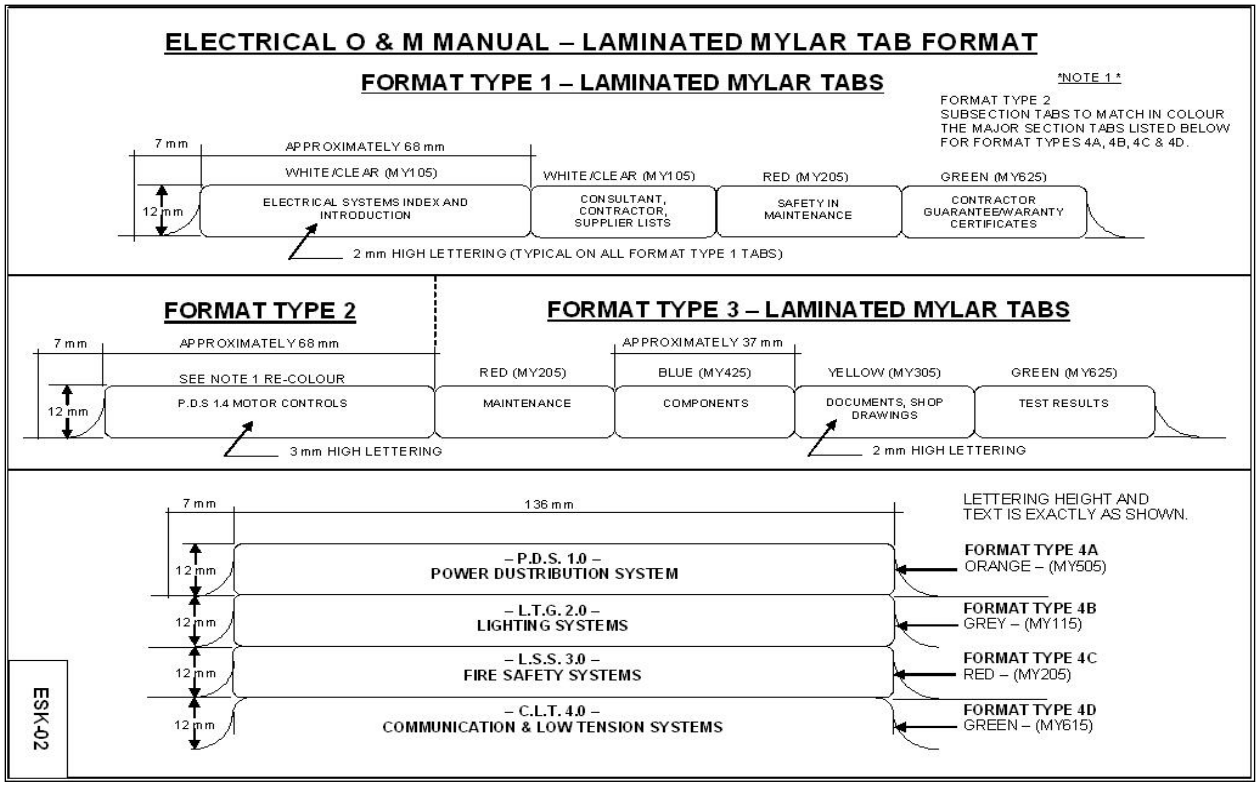
.7 Electrical O&M manuals to be assembled in 210 mm × 275 mm capacity, expanding spine catalogue binders complete with plated piano hinges, bound in heavy (*blue)* fabric, hot stamped white lettering on front and spine. Electrical contractor to provide sufficient quantity to allow all binders to hold system data while in full closed position (not expanded).

.8 Electrical contractor to provide sample of art work and fabric cover (before having binders constructed) to the Departmental Representative.

.9 Tab Name/Description — Tab No.

- .1 Incoming Electrical Services — 1.0
  - .1 – Power
  - .2 – Telephone
  - .3 – RFTV
- .2 Secondary Power Distribution System — 1.1
  - .1 – Main Distribution Switchgear
  - .2 – Metering
  - .3 – Energy Test Meter
  - .4 – Coordination Study
  - .5 – TVSS Units
- .3 Transformers — 1.3
  - .1 – Dry Type Transformers
  - .2 – Tap Adjustment Data
  - .3 – Connection Details
- .4 CDPs/Panelboards — 1.4
  - .1 – 347/600 Volt Distribution Centres
  - .2 – 120/208 Volt Distribution Centres
  - .3 – Moulded Case Feeder Breakers
  - .4 – 347/600 Volt and 120/208 Volt Panelboards
  - .5 – Contactors
  - .6 – Ground Fault Breakers
  - .7 – Final Typewritten Panel Directories
  - .8 – Auto Bypass Transfer Switches
  - .9 – TVSS Units


NOTES
* = WHERE APPLICABLE
ELECTRICAL O&M MANUAL
FORMAT TYPE "A" BINDERS. 240mm X 290mm EXPANDING BINDERS C/W PLATED PIANO HINGES, STAMPED LETTERING (WORDS AS PER OWNER). PROVIDE FINISHED BINDERS IN NON-EXPANDED STATE.
--O&M MANUAL TO BE PREPARED BY A SPECIALIZED DOCUMENTATION AGENT.
TITLE PAGE
WHITE TAB
ELECTRICAL SYSTEMS INDEX AND INTRODUCTION
- GRAPHIC O&M MANUAL STRUCTURE.
- TABLE OF CONTENTS FOR ALL ELECTRICAL O&M MANUALS.
- DETAILED WRITTEN MANUAL INTRODUCTION.
- SCHEDULED MAINTENANCE SUMMARY CHART COMPILED FROM EACH SECTION.
- WARRANTY/SCHEDULEC MAINTENANCE LOG SHEET (SAMPLE PROVIDED).
- WARRANTY/SCHEDULEC MAINTENANCE LOG SHEET (BLANK).
WHITE TAB
CONSULTANT/CONTRACTOR/SUPPLIER LIST
- NAMES, ADDRESSES, PHONE/FAX NO., LIST FOR EACH.
RED TAB
SAFETY IN MAINTENANCE
- DETAILED SUGGESTIONS AND RPOCEDURES INCLUDING A DETAILED LOCKOUT/TAGOUT PROGRAM.
GREEN TAB
CONTRACTOR WARRANTY/GUARANTEE CERTIFICATES
- WARRANTY LETTERS, INSPECTION AUTHORITY REPORTS.
P.D.S. 1.0 POWER DISTRIBUTION SYSTEMS
ORANGE TAB
SUBSECTION – P.D.S. 1.1 ORANGE TAB
SYSTEM #1 OPERATIONS, DESCRIPTIONS
- DETAILED WRITTEN DESCRIPTION, INCLUDING EQUIPMENT DETAILS, LOCATIONS, AND SCHEMATICS.
- * CONTROL DESCRIPTION/SCHEMATICS.
- * OPERATIONS DESCRIPTION
RED TAB
MAINTENANCE
- SCHEDULED MAINTENANCE PROCEDURES.
- SAFETY IN MAINTENANCE PROCEDURES.
- * DAILY, MONTHLY, WEEKLY, BI-YEARLY, YEARLY CHECKLISTS AND CHECKLIST CHARTS FOR EACH PIECE OF EQUIPMENT.
- * MANUFACTURER SCHEDULED MAINTENANCE CHARTS & CHECKLISTS.
- * WIRING DIAGRAMS/SCHEMATICS.
- * SPARE PARTS LIST.
- * CONTRACTOR PREPARED DATA COLLECTION SHEETS
BLUE TAB
COMPONENTS
- * DETAILED MANUFACTURER COMPONENT DATA.
- * DIRECTORIES.
- * SCHEDULES.
YELLOW TAB
DOCUMENTS, SHOP DRAWINGS
- SHOP DRAWINGS.
GREEN TAB
TEST RESULTS
- * MANUFACTURER'S TEST RESULTS, CERTIFICATION AND WARRANTY
- * CONTRACTOR'S TEST RESULTS
L.T.G. 2.0 – LIGHTING SYSTEMS
GREY TAB
F.S.S. 3.0 – FIRE SAFETY SYSTEMS
RED TAB
C.T.L. 4.0 – COMMUNICATIONS AND LOW TENSION SYSTEMS
GREEN TAB
ESK-01
GRAPHIC OPERATIONS & MAINTENANCE MANUAL STRUCTURE



END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 This Section of the Specification is to be read, coordinated and implemented in conjunction with all other parts of the Contract Documents.

1.2 REGULATORY REQUIREMENTS

.1 Restraints shall meet the requirements of the latest edition of the BC Building Code (BCBC) and amendments.

.2 The Seismic Engineer, herein also referred to as Seismic Consultant, shall be able to provide a proof of professional insurance and the related practice credentials if requested by the Electrical Consultant. The Seismic Consultant should be familiar with SMACNA, ECABC & NFPA guidelines as well as BCBC requirements.

.3 The Contractors Seismic Consultant shall submit original signed BCBC "Letters of Assurance" Schedules B and C-B to the Prime Consultant or Electrical Consultant.

.4 The above requirements shall not restrict or supplant the requirements of any local bylaws, codes, or other certified agencies which may have jurisdiction over all or part of the installation.

1.3 SCOPE

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

.2 Manufacturer's shop drawings to be submitted with seismic information on equipment structure, bracing and internal components and as required by Division 01.

.3 Provide restraint on all equipment and machinery, which is part of the building electrical services and systems, to prevent injury or hazard to persons and equipment in and around the structure. Restrain all such equipment in its normal position in the event of an earthquake.

.4 The total electrical seismic restraint design and field review and inspection will be by a B.C. registered professional structural engineer who specializes in the restraint of building elements. Contractor to allow for coordination, provision of seismic restraints, as well as all costs for the services of the Seismic Engineer. This engineer will provide normal engineering functions as they pertain to seismic restraint of electrical installations.

.5 The Contractor shall be aware of, and comply with, all current seismic restraining requirements and make provision for those that may come into effect during construction of the project. Make proper allowance for such conditions in the tender.

.6 The Seismic Engineer shall provide detailed seismic restraint installation shop drawings to the Contractor. Copies of the shop drawings to be included in the final project manual.

.7 Provide seismic restraints on all equipment, and/or installations or assemblies, which are suspended, pendant, shelf mounted, freestanding and/or bolted to the building structure or support slabs.

.8 The Seismic Engineer shall provide inspections during and after installation. The Contractor shall correct any deficiencies noted without additional cost to the contract.

.9 Include all costs associated with the seismic installation and certification in the base tender.

1.4 SHOP DRAWINGS & SUBMITTALS

.1 Submit shop drawings of all seismic restraint systems including details of attachment to the structure, either tested in an independent testing laboratory or approved by the Seismic Engineer.

.2 Submit all the proposed types and locations of inserts or connection points to the building structure or support slabs. Follow the directions and recommendations of the Seismic Engineer.

Part 2 Products

2.1 SLACK CABLE SYSTEMS

.1 Slack cable restraint systems shall be as designed and supplied by Vibra-Sonic Control or equal.

.2 Slack cable restraints shall be provided on suspended and shelf mounted transformers along with associated equipment and assemblies connected to them at the points of vertical support (4 points). The restraint wires shall be oriented at approximately 90deg to each other (in plan), and tied back to the ceiling slab or its structure at approximately 45deg to the slab or basic structure. The restraints shall be selected for a 1 g earthquake loading, i.e. each wire shall have a working load capacity equal to the weight of the transformer. The anchors in the structure shall be selected for a load equal to the weight of the transformers at a 45deg pull.

.3 Slack cable systems to allow normal maintenance of equipment and shall not create additional hazard by their location or configurations. Contractor shall rectify any such installations at no additional cost, all to the satisfaction of the engineer and inspection authority having jurisdiction.

.4 Coordinate requirements of slack cables with suppliers prior to installation.

Part 3 Execution

3.1 GENERAL

.1 All seismic restraints systems shall conform to local authority having jurisdiction and all applicable code requirements.

3.2 CONDUITS

.1 Provide restraint installation information and details on conduit and equipment as indicated below:

.2 Vertical Conduit:

.1 Attachment - Secure vertical conduit at sufficiently close intervals to keep the conduit in alignment and carry the weight of the conduits and wiring. Stacks shall be supported at their bases and, if over two stories in height, at each floor by approved metal floor clamps.

.2 At vertical conduit risers, wherever possible, support the weight of the riser, at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 9.2 m [30 ft] o.c.

.3 Riser joints shall be braced or stabilized between floors.

.4 Horizontal Conduits:

.1 Supports - Horizontal conduit shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.

.2 EMT tubing - tubing shall be supported at approximately 1.2 m [4 ft] intervals for tubing.

.5 Provide transverse bracing at 12.2 m [40 ft] o.c. maximum unless otherwise noted. Provide bracing at all 90o bend assemblies, and pull box locations.

.6 Provide longitudinal bracing at 24.4 m [80 ft] o.c. maximum unless otherwise noted.

.7 Do not brace conduit runs against each other. Use separate support and restraint system.

.8 Support all conduits in accordance with the capability of the pipe to resist seismic load requirements indicated.

.9 Trapeze hangers may be used. Provide flexible conduit connections where conduits pass through building seismic or expansion joints, or where rigidly supported conduits connect to equipment with vibration or seismic isolators.

.10 A conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode

during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

.11 Provide large enough conduit sleeves through walls or floors to allow for anticipated differential movements with firestopping where required.

.12 It is the responsibility of the contractor to ascertain that an appropriate size restraint device be selected for each individual piece of equipment. Submit details on shop drawings. Review with seismic consultant and submit shop drawings to consultants for their reference.

3.3 FLOOR MOUNTED EQUIPMENT

.1 Bolt all equipment, e.g. transformers, switchgear, generators, motor control centres, free standing panelboards, control panels, capacitor banks, etc. to the structure. Design anchors and bolts for seismic force applied horizontally through the center of gravity to a seismic force of 0.5g. For equipment which may be subject to resonances, use a nominal 1.0 g seismic force.

.2 Provide flexible conduit connections between floor mounted equipment to be restrained and its adjacent associated electrical equipment.

3.4 LUMINAIRES

.1 Fluorescent luminaires in suspended ceilings shall be hung independently of the ceiling system. Luminaires shall be secured to concrete or structural deck above by at least two taut cables which are connected to the luminaire at diagonal points.

.2 Surface and recessed style luminaires shall be hung independently of the ceiling system. Luminaires shall be secured to concrete or structural deck above by taut cables.

.3 Luminaires which are hung independently of ceiling systems shall have minimum of one seismic cable in addition to the chain or cable used to support the luminaire. Seismic restraint cables shall be secured into the concrete or structural deck above.

.4 Cables shall be corrosion resistant and approved for the application.

.5 Luminaires which are rod hung shall have seismic ball alignment fittings at the ceiling and fixture.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 TERMS OF REFERENCE

.1 Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated.

.2 Aluminium conductors only permitted where indicated on drawings and then typically only for feeder conductors larger than 3/0 AWG. All conductor sizes indicated on drawings are based on copper conductors unless otherwise noted.

.3 Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 system volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 1000 volt having a PVC jacket with FT-4 flame spread rating.

.4 Flexible armoured cabling (BX) shall not be used for the general wiring system other than drops from final junction box to recessed luminaires in concealed locations. Limit of four (4) drops allowed from final junction box. BX cabling shall not exceed 30 feet.

.5 Cabling indicated to be 2-hour fire-rated shall be Mineral Insulated or compliant to CAN/ULC-S139 and CSA 38-95 (Draka Lifeline, Raychem RHW, Shawflex, or equivalent). Cabling shall be low smoke halogen free. Conduit to be sized and installed as per manufacturers' requirements for these specialized cables and assemblies regardless of the size indicated on drawings.

.6 Provide all control wiring except HVAC controls as specified in Mechanical Divisions.

.7 Refer to equipment schedule(s) for detailed responsibilities.

.8 Non-metallic sheathed wiring is not to be used on this project.

1.3 PRODUCT DATA

.1 Provide product data in accordance with Division 01

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated

containers.

Part 2 Products

2.1 WIRING & CABLES – GENERAL

.1 Conductors: stranded for 10 AWG and larger. Minimum size #12 AWG.

.2 Insulation to be 600V RW90XLPE (X link) for general building wiring in conduit.

.3 Use RWU90XLPE for underground installations.

.4 Main feeders to be conduit and copper insulated wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.

.5 Armoured (BX) cable may only be utilized for recessed tee bar luminaire drops from ceiling mounted outlet boxes. "Tite Bite" connectors and their counterparts of other manufacturers shall not be used. Use anti-short connectors. Cable from luminaire to luminaire is discouraged. Allow nominally 900mm [3'] extra cable looped and supported in the ceiling space to permit luminaire relocations of one tile space.

.6 TBS90 #14 AWG stranded shall be used in all switchgear assemblies. Current transformer secondary wiring shall be #12 AWG stranded. Current transformer leads shall incorporate ring type tongues for termination purposes

.7 Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No. 8 gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and condulet fittings. Conductors not to be painted.

2.2 ARMOURED CABLE (*BX*)

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90 600V rated.

.3 Armour: interlocking type fabricated from galvanized steel.

.4 Anti-short connectors.

2.3 LOW VOLTAGE CONTROL CABLES

.1 Type LVT, or equivalent: soft annealed copper conductors, with thermoplastic insulation, outer covering of thermoplastic jacket. Minimum size #18 AWG.

.2 Unless otherwise specified wiring to be multicore individually identified and

colour coded with grey sheath enclosed in conduit or (EMT).

2.4 WIRE & BOX CONNECTORS

.1 Pressure type wire connector current carrying parts to be copper and sized to fit conductors used.

.2 Fixture type splicing connector current carrying parts to be copper sized to fit conductors 10 AWG or less.

.3 Bushing stud connectors to EEMAC 1Y-2 and suitable for stranded copper conductors

.4 Clamps or connectors for armoured cable, flexible conduit, as required.

Part 3 Execution

3.1 INSTALLATION

.1 Install all cables and wiring.

.2 Conductor length for parallel feeders to be identical. Provide permanent plastic nametag indicating load fed.

.3 Group Teck, Armoured, MI & Sheathed cables on channels wherever possible.

.4 Lace or clip groups of feeder conductors at all distribution centres, pullboxes, and termination points.

.5 Wiring in walls should typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls should be avoided unless indicated.

.6 All grounding conductors and straps to be copper. All bonding conductors to have green insulation jacket.

.7 Colour coding to be strictly in accordance with Section 26 05 00.

.8 Provide sleeves where cables enter or exit cast concrete or masonry.

.9 Power wiring up to and including No. 6 gauge shall be spliced with nylon-insulated expandable spring-type connectors. Large conductors shall be spliced using split-bolt or other compression type connectors wrapped with cambric tape then PVC tape.

.10 Wires shall be sized for 2% maximum voltage drop to farthest outlet on a loaded circuit. Increase home run cable size to meet these requirements.

.11 All 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.

.12 Install all control cables in conduit.

.13 Provide numbered wire collars for all control wiring. Numbers to correspond to control drawing legend. Obtain wiring diagram for control wiring of other Divisions.

3.2 VOLTAGE REGULATION

.1 The drawings are diagrammatic and indicate the general routing of conduit runs and not exact routing, either horizontally or vertically.

.2 Branch circuit conductor sizes shall be #12 AWG or larger based on the Canadian Electrical Code CSA 22.1 Section 8, which allows a maximum 3% voltage drop for branch circuits.

3.3 WIRE & BOX CONNECTORS

.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

.2 Install fixture type connectors and tighten. Replace insulating cap.

.3 Install bushing stud connectors in accordance with EEMAC 1Y-2

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 19 – Waste Management and Disposal.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

.2 Transformer grounding shall comply with CSA C22.2 No.41.

.3 All grounding conductors to be stranded soft annealed copper unless otherwise noted.

.4 Install complete grounding and bonding system in accordance with Canadian Electrical Code and local inspection authority requirements.

1.4 TESTING REQUIREMENTS

.1 Perform ground continuity and resistance tests using method appropriate to site conditions. Measure ground grid resistance.

.2 Any third party testing agency costs for the testing and reporting shall be included in the Electrical Division base tender and shall be carried out by a pre-approved testing agency.

1.5 ADDITIONAL SCOPE

.1 Refer to drawings for extent of grounding in addition to code requirements.

Part 2 Products

2.1 MATERIALS

.1 Grounding equipment to: CSA C22.2 No.41.

2.2 EQUIPMENT

.1 Clamps for grounding of conductor, size as required.

.2 Copper conductor at least 6m [20'] long for each concrete encased electrode, bare, stranded, soft annealed, size as indicated. If not indicated, use 3/0AWG which is the maximum in Table 43 CEC.

.3 Rod electrodes, copper clad steel 20mm [3/4"] dia by 3m [10'] long or as indicated.

.4 System and circuit, equipment, grounding conductors, bare stranded copper, soft annealed, sized as indicated. Insulation where specified or required to be green.

.5 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

.6 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.

2.3 STANDARDS OF ACCEPTANCE

.1 Acceptable manufacturers:

.1 Burndy Corp, or equivalent.

.2 Erico Inc, or equivalent.

.3 Cadweld, or equivalent.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.

.2 Provide ground wire in EMT conduits installed in grade or below slabs.

.3 Install connectors in accordance with manufacturer's instructions.

.4 Protect exposed grounding conductors from mechanical injury.

.5 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process or permanent mechanical connectors approved for the use.

.6 Use mechanical connectors for grounding connections to equipment provided with lugs.

.7 Soldered joints not permitted.

.8 Install bonding wire for flexible conduit, connected at both end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit. Provide a ground

conductor in all flexible conduit and secure to system grounding lugs at both the equipment and source.

.9 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.10 Connect building structural steel and metal siding to ground by welding copper to steel.

.11 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.12 Bond single conductor, metallic armoured cables to cabinet at supply end and provide non-metallic entry plate at load end.

.13 Ground secondary service pedestals.

.14 Coordinate ground rod installation with local soil conditions to assure proper grounding system.

.15 Provide a grounding/bonding bus in each electrical room. Connect a #2/0 CU bonding conductor or as shown on the drawings between grounding/bonding buses.

.16 Provide a bonding conductor appropriately sized within each raceway routed within the building.

.17 All bonding and grounding connections to be compression type unless noted otherwise.

.18 Bond bonding bus of switchboard to the grounding grid with a #3/0 copper conductor.

.19 Ground the secondary winding of potential and current transformers.

.20 Supply and install complete grounding and bonding system as indicated and as required by Canadian Electrical Code and the local electrical inspection authorities.

.21 Provide grounding/bonding bus bars mounted on standoff insulators or as shown on the drawings.

.22 All components shall be securely and adequately bonded and where required to accomplish this, bonding jumpers, grounding studs and bushings shall be used.

.23 Ensure that all raceways, terminal panels, etc. for fire alarm, etc. are securely and adequately bonded and provide grounding conductor to main ground bus where called for or when required.

.24 All interior metallic gas piping which may become energized to be made electrically continuous and to be bonded in accordance with requirements of Canadian Electrical Code.

.25 Bond all low tension equipment with #6 AWG bonding conductor.

.26 Bond all structural steel, all concrete reinforcing steel and all metal systems with a #2 copper bonding conductor. Connect to closest ground bus or bonding point.

.27 All metallic conduits longer than 1m in length, containing a single grounding or bonding conductor, shall be bonded as per the Canadian Electrical Code.

3.2 BUILDING SERVICES BONDING

.1 WATER - From the main electrical room ground bus, connect 1#3/0 insulated ground conductor in 27mm [1"] conduit to water main with approved ground clamp ahead of water meter. Install 1#3/0 ground conductor jumper strapped around water meter and associated unions and valves to ground building side of water system.

.2 METALLIC WASTE WATER PIPING - Each metallic waste water piping system to the building to be grounded by bonding it to the interior metallic water supply system by copper bonding jumper of not less than No.6 AWG as per the Canadian Electrical Code

.3 GAS PIPE GROUNDING - All interior metallic gas piping which may become energized to be made electrically continuous and to be bonded in accordance with requirements of Canadian Electrical Code.

3.3 GROUNDING BUSSES

.1 Provide a ground bus in the main electrical room. Ground bus shall consist of suitable length of 50mm x 6mm [2"x ¼"] copper bus mounted on a 25mm [1"] insulating standoffs. This bus shall be drilled and tapped to receive all the grounding conductors indicated and an engraved nameplate or tag installed above or below individual conductors indicating their function.

.2 Provide similar ground bus in each sub electrical room and major mechanical room. Interconnect to the main ground bus with a #3/0 AWG insulated copper grounding conductor that is typically installed with the power feeders.

.3 Provide similar ground bus in each data and voice equipment room and closet as indicated in "Data & Voice Grounding" clause.

.4 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 3/0 AWG or as indicated.

.5 Copper or bronze lugs required for termination of all copper conductors at ground busses.

3.4 EQUIPMENT GROUNDING OR BONDING

.1 Install grounding or bonding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, UPS, control panels, building steel work, distribution panels and outdoor lighting.

.2 Provide a grounding conductor from the secondary of every distribution transformer to the grounding system. Ground conductor to be sized and installed in accordance with Canadian Electrical Code.

.3 Provide grounding conductor(s) from all major switchgear to solidly ground the secondary system. This includes equipment located in the main electrical room as well as each sub-electrical room. Grounding conductors to be sized to Canadian Electrical Code and switchgear manufacturer's requirements.

3.5 MECHANICAL EQUIPMENT GROUNDING

.1 Provide a #2 ground conductor from the mechanical room ground bus to each MCC.

.2 Provide a #6 ground conductor from the mechanical room ground bus to each VFD

.3 Ground wires to be installed in all conduit serving motor feeder circuits and to extend to ground screws on junction and outlet boxes for bonding.

3.6 SYSTEMS GROUNDING

.1 Install home run a #6 AWG insulated bonding conductor in conduit from the main ground bus to the:

.1 Sound and Communication systems head end.

.2 RF Television system

.3 Uninterruptable Power Supply (UPS) system(s)

3.7 DATA & VOICE GROUNDING

.1 Install home run insulated ground conductor in conduit from the building main ground bus as follows:

.1 #2 AWG to a ground bus in the main data equipment room.

.2 #2 AWG to a ground bus in the main telephone equipment room.

.3 #2 AWG to a ground bus in each telephone backboard in equipment rooms/closets.

.2 Unless otherwise solidly bonded, bond all data and telephone incoming and outgoing steel conduits with insulated 1#12 AWG from the nearest “Communication” ground bus.

.3 Provide telephone grounding system in accordance with telephone company's requirements.

3.8 CABLE TRAY BONDING

.1 Install 1#6 to each cable tray from nearest ground bus.

.2 Install 1#6 bare copper ground, unless shown otherwise, for full length of tray bonded to tray at 15m [50'] intervals and to ground bus at each termination point as specified.

3.9 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.

.3 Measure ground grid resistance with earth test megohmmeter and install additional ground rods and conductors as required until resistance to ground complies with Code requirements and is less than 1Ω.

.4 Carry out all tests required by the Electrical Inspection Authority and provide all required reports and copied to the Departmental Representative. Include all associated costs.

.5 Ensure test results are satisfactory before energizing the electrical system.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data for cabinets in accordance with Section 26 05 00 and 01 33 00.

Part 2 Products

2.1 SPLITTERS

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Main and branch lugs, connection bars to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm [1”] minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

.1 Type E: sheet steel, hinged door and return flange overlapping sides, handle and catch, for surface mountings.

.2 Type T: sheet steel cabinet, with full length hinged door, latch, lock, 2 keys, containing 19 mm G1S fir plywood backboard for surface or flush mounting as appropriate.

.3 Include filtered vents and/or fan-cooling when enclosed equipment is heat producing.

2.4 FINISHES

.1 Apply finishes in accordance with Section 26 05 00.

Part 3 Execution

3.1 SPLITTER INSTALLATION

.1 Install splitters as indicated and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible spaces.

.2 Only main junction and pull boxes are indicated. Provide pull boxes so as not to exceed 30 m of conduit run between pull boxes.

.3 Provide pull boxes and junction boxes in locations shown on the drawings and as required to suit job conditions.

.4 Locate pull boxes and junction boxes above removable ceilings, in electrical rooms, utility rooms or storage areas.

.5 Junction boxes, when used, to be installed in areas that are accessible through luminaire openings, and/or access panels.

.6 Where pull boxes are flush mounted, provide overlapping covers with flush head cover retaining screws, prime coated and painted to match wall or ceiling finish.

.7 Where cast corrosion resistant boxes are used, covers to be of matching type and gasketted.

.8 For special (not 100mm [4"] square or octagonal) pull boxes and/or junction boxes, paint identification for the system and provide lamicoid nametags to box covers with a size 2 nameplate 5mm [0.25"] lettering identifying system.

.9 Interior of all pull boxes and junction boxes for each system to be spray painted with colour as specified in Section 26 05 00

.10 All pull boxes, junction boxes and cabinets to be supported directly from building structure using one or a combination of galvanized screws, galvanized bolts, galvanized rods, and approved box clip.

.11 Support of pull boxes, junction boxes by conduit fittings or wire is not acceptable.

3.3 CABINETS INSTALLATION

.1 Mount cabinets with top not higher than 2 m [6'] above finished floor.

.2 Cabinets shall be flush mounted in finished areas where depth can be accommodated in the walls. Provide flush trim to suit.

.3 Provide fit up in Type T cabinets as indicated.

3.4 IDENTIFICATION

.1 Install size 2 identification labels indicating system name, voltage and phase in accordance with Section 26 05 00.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 – Waste Management and Disposal.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 REFERENCES

.1 All conduits and accessories to be manufactured and certified by the related CSA standard.

1.4 SCOPE

.1 Drawings do not show all conduits. Those shown are in diagrammatic form only.

.2 Conceal all conduits where possible in finished areas. Conduits may be surface mounted either only where indicated or in service areas accessible only to authorized personnel.

.3 If a finished area is concrete (existing) or concealment is not practical, obtain ruling from Departmental Representative where exposed wire mold may be substituted.

.4 Note particular requirements for routing of conduits where detailed.

.5 Provide polypropylene pull cord in all “empty” conduits.

Part 2 Products

2.1 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No.45 Galvanized Steel.

.2 Electrical Metallic Tubing (EMT): to CSA C22.2 No.83.

2.2 CONDUIT FASTENINGS

.1 One-hole steel straps to secure surface conduits 41mm [1.5”] and smaller. Use two-hole steel straps to conduits larger than 41mm [1.5”].

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits.

.4 10mm [3/8”] threaded rods to support suspended channels.

2.3 CONDUIT FITTINGS

.1 Fittings manufactured for use with conduits specified. Coating same as conduit.

.2 Provide factory "ells" where 90 degree bends are required for 27mm [1”] and larger conduits.

.3 EMT couplings and connectors shall be steel, or Regal Die-cast zinc alloy, or equivalent. Couplings used on conduit containing fire-rated cable shall be steel. Regular die-cast alloy fittings and couplings are not acceptable. Provide plastic bushings (insulated throat) for all connectors unless there is no chance of burrs. Provide water-tight connectors in damp or wet locations and for surface equipment (e.g. panelboards, MCC’s, etc.) in rooms that are fire sprinkler protected.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable linear expansion.

.2 Water-tight expansion fittings: with integral bonding jumper, suitable for linear expansion and 21mm [3/4”] deflection in all directions.

.3 Weatherproof expansion fittings for linear expansion at entry to panel as required.

2.5 RIGID P.V.C. CONDUIT

.1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride as manufactured C.G.E. "Sceptre", or equivalent.

.2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.

.3 Solvent: as recommended by conduit manufacturer.

2.6 CABLE TRAY

.1 All ventilated and ladder tray to be steel, complete with angles, offsets, corners, saddles, tees, etc. as indicated and required to suit the installation.

.2 All non-ventilated tray shall be fabricated of rolled sheet steel or aluminum. All steel non-painted tray shall be hot dip galvanized after fabrication to CSA G164. ASTM designation A386. All tray to be Class C1.

.3 All tray shall have 45 degree corners at all vertical and horizontal corners, tees and width change locations.

.4 Cable tray to have a minimum cable loading depth of 114mm [4.5”]. Cable tray width to be a minimum of 305mm [12”] wide for communications, or as indicated on drawings

.5 Cable tray width to be a minimum of 450mm [18”] wide (ladder type) for power cables.

.6 Suspended tray supports to be trapeze style hangers of minimum 40mm [1.5"] square "Unistrut" supported from 9.5mm [3/8"] threaded rod hangers from preset or afterset concrete inserts or direct steel support.

.7 Barriers where specified, to be continuous metal dividers for entire length of the tray.

2.7 SURFACE RACEWAYS

.1 Removable cover finished painted steel surface raceways.

.2 Internal barriered to provide physical separation between power and communication cabling.

.3 Colour to be as indicated on the drawings or where not indicated confirm with Departmental Representative before ordering.

.4 All raceway fittings to be accessories available from the manufacturer.

.5 Standard of acceptance:

.1 Wiremold 3000 (39mm x 70mm), 4000 (44mm x 121mm), or 6000 (90mm x 121mm), as indicated on the drawings or as required for wiring capacity.

.2 Or equivalent.

.6 All product to be from the same manufacturer.

2.8 OUTLET AND CONDUIT BOXES IN GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm [4"] square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.

.4 Blank cover plates for boxes without wiring devices.

.5 347V outlet boxes for 347V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

.7 Bushing and connectors with nylon insulated throats.

.8 Knock-out fillers to prevent entry of foreign materials.

.9 Conduit outlet bodies for conduit up to 35 mm [1.25"]. Use pull boxes for larger conduits.

.10 Double locknuts and insulated bushings on sheet metal boxes.

2.9 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm [3" x 2" x 1.5"] or as indicated. Larger 102 mm square x 54mm deep [4"x 2"] outlet boxes (No. 52151 or

52171) to be used when more than one conduit enters one side. Provide extension and plaster rings as required.

.2 For larger boxes use GSB solid type as required.

.3 Boxes for surface mounted switches, receptacles, communications, telephone to be 100mm square No. 52151 or 52171 with Taylor 8300 series covers.

.4 Lighting fixture outlets: 102 mm [4"] square outlet boxes (No 52151, 52171 or 72171) or octagonal outlet boxes (No 54151 or 54171).

.5 102 mm [4"] square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

2.10 MASONRY BOXES

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

2.11 CONCRETE BOXES

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

2.12 FLOOR BOXES

.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with faceplate. Device mounting plate to accommodate short or long ear receptacles. Minimum depth: 28 mm [1.1"] for receptacles; 73 mm [2.9"] for communication equipment.

.2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16 mm [0.5"] and 21 mm [0.75"] conduit. Minimum size: 73 mm [2.9"] deep

2.13 SURFACE CONDUIT BOXES

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

Part 3 Execution

3.1 CONDUIT - GENERAL

.1 Generally use electrical metallic tubing (EMT) in the building interior and in above grade slabs except where subject to mechanical injury or where otherwise indicated.

.2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Set out the work and coordinate with other services prior to installation. Maintain access to junction and pull boxes.

.3 Where practical conceal conduits.

.4 Any conduit exposed in finished areas to be free of unnecessary labels and trade marks.

.5 All conduit ends to be reamed to ensure a smooth interior finish that will not damage the insulation of the wiring.

.6 Ensure grounding continuity in all conduit systems.

.7 Surface conduits are acceptable in mechanical and electrical service rooms and in unfinished areas or where indicated.

.8 Use rigid galvanized steel (RGS) threaded conduit where the installation is subject to mechanical injury. In any event, use RGS conduit for surface installations up to 1.5m [5'] above the finished floor.

.9 Field threads on rigid conduit shall be sufficient length to draw conduits ends together.

.10 Unless otherwise noted and where practical, all conduits to be routed through the ceiling space rather than in, or below, slabs or floor structures to facilitate future changes.

.11 Conduits in walls should typically drop (or loop) vertically from above to better facilitate future renovations. Generally conduits from below and horizontal conduits in walls and concrete structures should be avoided unless indicated.

.12 All branch circuit conduit, home-runs and communication/data conduits to be minimum 21 mm [3/4"] diameter unless otherwise indicated.

.13 Generally use Rigid PVC conduits in or below ground level slab unless otherwise noted. Transition to RGS conduit in exposed locations: eg where conduits emerge from ground level slab.

.14 Conduits are not permitted in terrazo or concrete toppings.

.15 Cap turned up conduits to prevent the entrance of dirt of moisture during construction.

.16 Locate conduits more than 75mm [3"] parallel to steam or hot water lines with a minimum of 25mm [1"] at crossovers.

.17 Bend conduits cold, so that conduit at any point is not flattened more than 1/10th of its original diameter. Conduits bent more than this or kinked to be replaced.

.18 Provide polypropylene pull cord in empty conduits to facilitate pulling wiring in future.

.19 Where conduits become blocked, the use of corrosive agents is prohibited. Remove and replace blocked section.

.20 Damaged conduits to be repaired or replaced.

.21 Dry conduits out thoroughly before installing wiring. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.22 Conduits shall not pass through structural members except as indicated.

.23 Conduit sizes indicated on drawings are minimum only. Increase sizes as required to suit alternative wiring types or to comply with Code.

.24 Conduits and ducts crossing building expansion joints shall have approved conduit expansion fittings to suit the type of conduit used.

.25 Seal conduits with approved sealant where conduits are run between heated and unheated areas.

.26 Seal openings with approved sealant where conduits, cables, or cable trays pierce fire separations.

.27 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits are installed, wall openings shall be closed with material compatible with the wall construction and/or to meet any fire separation integrity.

.28 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.

.29 Use "condulet" fittings for power and telephone type conduit terminations in lieu of standard boxes where box support is not provided.

.30 Provide necessary roof jacks or flashing where conduits pass through roof or watertight membranes. Apply approved sealant to maintain membrane integrity.

.31 Use flexible metal conduit for connection to recessed incandescent luminaires without a prewired outlet box and connection to recessed fluorescent luminaires.

.32 Use liquid tight flexible metal conduit for connection to motors, and other vibrating equipment and transformers.

.33 Use explosion proof flexible connection for connection to explosion proof motors.

.34 Install conduit-sealing fittings in hazardous areas, isolation rooms and clean rooms. Fill with compound.

3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with minimum 1.5m [5’] clearance.

.3 Conduits to be run in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended and/or surface channels.

.5 Surface conduits will not be accepted in finished areas unless detailed.

3.3 SPARE CONDUITS

.1 Provide spare conduits as indicated.

.2 Provide 2x27 mm [1"] spare conduits up to ceiling space and 2x27 mm [1"] spare conduits down to ceiling space below from each flush panel. Terminate the conduits in 150x150x100 mm [6"x6"x4"] junction boxes in ceiling spaces or in case of an exposed concrete slab, terminate each conduit in a flush concrete box. Provide coverplates for all junction boxes.

3.4 CABLE TRAY INSTALLATION

.1 Use ventilated cable tray for Voice/Data service cable down drops in the Communication Rooms

.2 Support suspended cable tray from trapeze style hangers with hangers spaced as recommended by the manufacturer based on a maximum load capacity for the tray. Support trays at all corners, offsets and tee fittings

.3 Where shown and appropriate, support cable tray from wall using a cantilever support arrangement. Cable trays may be supported using wall mounted support on masonry walls or from the building steel only.

.4 Cable tray location and mounting heights to be coordinated on site with other trades to provide minimum headroom and serviceability. Verify drawing details to allow for all services run in ceiling spaces. Provide vertical and horizontal offsets as required to suit job site conditions.

.5 Cable tray sections shall be joined by approved connector plates and rust-resistant (plated) hardware. Torque all hardware as per manufacturer's recommendations.

.6 Cables shall be secured in place in tray with tie wraps where in horizontal runs and with cable clamps in vertical runs. Low tension cabling shall be secured to tray by use of Velcro style straps. Support cables routed vertically through a service riser with a basket type wire grip equal to Hubbell Kellems grip for power cables and data cables including fiber optic cables.

.7 Bond all tray continuously with #6 AWG bond wire installed within all cable trays and connected to each length of tray by a ground clamp. Connect bonding conductor to building ground system at one or both ends

.8 Provide pulleys and rollers to install cables.

.9 Where cable tray passes through fire separations install fire pillows as required to maintain proper fire rating.

3.5 SURFACE RACEWAYS

.1 Where practical provide regularly spaced device outlets and factory pre-cut raceway covers and cover plates. Field install outlets where factory installation is not possible due to delivery issues or irregularly spaced outlet requirement. In this event covers may be field cut with proprietary factory cover shear equipment with sharp blades.

.2 Raceways shall be free of burrs inside and out.

.3 Covers to be matching colour, smooth, free of burrs and parallel with no gaps.

.4 Preserve and organize the space within the wireway to facilitate multiple wiring runs and future additions. In finished areas and where practical, conduit to feed the surface raceway from a box recessed behind and via grommetted openings to the back of the surface raceway. Maintain pullbox access as required by the Canadian Electrical Code.

3.6 BOXES INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.

.3 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of construction material. Remove upon completion of work.

.4 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm [0.25”] of opening.

.5 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers not to be used.

.6 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.

.7 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.

.8 No sectional or handy boxes to be installed.

.9 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.

.10 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.

.11 Outlets installed back to back in party stud walls to be off-set by one stud space.

.12 Refer to wiring device and communication specification sections and to architectural layouts for mounting heights of outlet boxes.

.13 Back-boxes for all communications systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the communications sections of these specifications.

.14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.

.15 Where outlet boxes penetrate through a fire separation, ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

.2 Section 26 09 24 "Lighting Controls" includes low voltage relays assemblies that are to be factory installed and prewired, within adjoined matching panel tubs and trims that are part of this section. Refer to section 26 09 24 for scope and extent.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 – Waste Management and Disposal.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 26 05 00 and 01 33 00.

.2 Shop drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

.3 Shop drawings to include matching tub and trim details for factory installed low voltage relay cabinets where specified.

1.4 PLANT ASSEMBLY

.1 Install circuit breakers in panelboards before shipment from plant.

.2 Install and prewire low voltage relays assemblies where indicated.

.3 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.4 All panelboards to be of a common manufacturer.

1.5 FINISH

.1 Apply finishes in accordance with Section 26 05 00.

.2 Panel finish in electrical and equipment rooms and closets to be standard ASA Grey baked enamel for normal power service and Blue for emergency power service. Confirm with Departmental Representative prior to shop finishing panels.

.3 Panels in finished and/or public areas to be either as clause .2 above or prepared to accept painting to closely match surroundings as directed by the Architect. In the later instance, the final paint coat to be done by Divison 09 but coordinated by the Electrical Division in particular for

protection and masking of locks and sensitive parts. Confirm with Departmental Representative prior to paint finishing panels.

Part 2 Products

2.1 PANELBOARDS, DOORS AND TRIMS

.1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.

.2 Bus and breakers rated for 10 KA symmetrical, minimum, interrupting capacity or as indicated.

.3 Tin plated aluminum bus with full size neutral.

.4 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.

.5 Mains, number of circuits and number and size of branch circuit breakers as indicated.

.6 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank fillers for all spaces.

.7 Concealed hinges and concealed trim mounting screws, hinged locking door with flush catch.

.8 Panelboards to have flush doors (gasketed where required).

.9 Provide two keys for each panelboard and key similar voltage panelboards alike.

.10 Panel tubs to be typically 600mm [20”] wide.

.11 Provide "sprinkler-proof" design in areas where sprinkler fire protection is installed. In any event, all surface mounted enclosures to be complete with sprinkler drip cover.

.12 Provide door within door trims where indicated to facilitate ease of service maintenance Each tub trim cover to be hinged and self supporting and to swing out to expose breaker cable terminations and wireways. Hinged trim shall be secured with cover screws on opening side by concealed machine screws. Hinged breaker cover shall be recessed into the hinged overall tub cover. Breaker cover shall have latch type closures. Submit details on shop drawings prior to manufacturing.

2.2 CUSTOM BUILT PANELBOARD ASSEMBLIES

.1 Relay section(s) on side(s) of panels as indicated or required for installation of low voltage remote control switching components. Coordinate with lighting controls equipment supplier

.2 Double stack panels as indicated.

.3 Contactors in mains as indicated.

.4 Feed through lugs as indicated.

.5 Provide Isolated ground bus as indicated. Isolated ground bus to be similar to neutral.

2.3 BREAKERS

.1 All breakers to be bolt on type, moulded case, non adjustable and non interchangeable trip, single, two and three pole, 120/208(240)V or 347/600V and with trip free position separate from "On" or "Off" positions.

.2 Two and three pole breakers to have common simultaneous trip and able to be located in any circuit position within the panelboard. Minimum interrupting rating of breakers to be as follows:

.1 347/600V panelboards - 14,000 Amps at 347 volts.

.2 120/208V panelboards - 10,000 Amps at 250 volts.

.3 Main breaker to be separately mounted at top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Provide circuit breakers with indicated trip ratings as shown in the panelboard schedules.

.5 Provide at least 10% spare 15 Amp single pole breakers whether indicated or not.

.6 Provide GFI type breakers as indicated.

.7 Provide lock-on devices as indicated and in any event for fire alarm circuits, security equipment circuits, EXIT sign circuits and emergency battery equipment circuits.

2.4 PANELBOARD IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00.

.2 Nameplate for each panelboard size 5 (2 line) engraved as indicated and include panel designation and voltage/phase.

.3 Complete circuit directory with typewritten card(s) located in slide-in plastic pocket(s) fixed to the back of the related door. Directory card to indicate the panel designation, mains size, voltage/phase and the location and load controlled of each circuit. Include a “letter sized” paper copy of each directory in the project maintenance manual.

.4 Provide a plasticized typewritten information card fixed to the back of each panel door. Information card to indicate the panel designation and location, feeder type and size and locations of any controlling contactors and feeder pullboxes. Include a “letter sized” paper copy of each information card in the project maintenance manual.

2.5 STANDARD OF ACCEPTANCE

.1 Cutler Hammer Type PRL Door, or equivalent, within door trim where indicated.

.2 Schneider, Type NQOD Door, or equivalent, within door trim where indicated.

.3 Siemens Canada, or equivalent.

Part 3 Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.

.2 Panelboards located in service rooms, mechanical rooms, and electrical rooms to be mounted on unistrut supports.

.3 Mount panelboards to height given in Section 26 05 00 or as indicated.

.4 Connect loads to circuits as indicated.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

.6 Install 4x27mm [1”] empty conduits (or equivalent) from each flush mounted panelboard single tub to ceiling space above and 2x27mm [1”] empty conduits (or equivalent) from each flush mounted panelboard single tub down to ceiling or space below where space exists.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 SCOPE OF WORK

.1 In general, the HVAC and the plumbing and fire protection motors and drives will be respectively provided under the Mechanical Division and Plumbing/Fire Protection Divisions. Refer to the related division of the specifications and drawings for exact locations and requirements.

.2 Provide the following components:

.1 All disconnect switches required.

.2 All starters, contactors, control transformers, except where supplied by the Mechanical or Plumbing/Fire Protection Divisions as noted in the equipment schedule.

.3 Thermostats, solenoid valves, pressure switches, aquastats, flow switches, timeclocks are generally provided by the Mechanical or Plumbing Divisions except as noted in the equipment schedule(s).

.4 Refer to equipment schedule(s) for details of motor controls and devices.

.5 Provide all power wiring from power distribution centre, through starter and control equipment to the motors.

.6 Conduit, wire and connections for all HVAC low voltage control wiring shall be the responsibility of Mechanical Division unless otherwise specified.

.7 Provide, connect and verify all Fire Alarm control wiring and devices.

1.3 CONTROLS - GENERAL

.1 Mechanical and Plumbing Divisions differ both in regard to the particulars of drives, motors, etc. specified. The Mechanical Division typically includes a major section on controls whereas the Plumbing Division typically includes more package equipment requiring power service connection only. Because of these variations the demarcation point between the work of the Electrical Division and the Mechanical and Plumbing Divisions typically differ.

.2 Generally for drives, equipment, etc. detailed in the Mechanical Division, the work of the Electrical Division finishes with the supply of a standard terminal block array for each starter. All further wiring, relays, timers, etc., together with control consoles, are provided under the Mechanical Division.

.3 Generally for the package equipment, drives and special controls detailed in the Plumbing Division, the work of the Electrical Division typically includes the provision of all wiring, devices, etc to complete each system and left ready for commissioning, set up, etc. by the Plumbing Division.

1.4 ELECTRICAL DIVISION RESPONSIBILITIES FOR MECHANICAL DIVISIONS

.1 Provide a ten point terminal block for each starter or contactor.

.2 Provide interwiring between starters or contacts and terminal blocks. Starter to be entirely factory-wired.

.3 Terminals to be as follows:

.1 120 V line from control transformer.

.2 Terminals for remote 3 wire stop/start.

.3 HOA or other control.

.4 120V neutral.

.5 Normally open dry contact.

.6 Common.

.7 Normally closed dry contact.

.8 Normally open dry contact.

.9 Common.

.10 Normally closed dry contact.

.4 Except where otherwise indicated, the work of the Electrical Division shall not extend beyond the control terminal blocks. The Mechanical Division shall provide all conduit, wire, wiring connections and components such as relays, timers, etc. as required to provide the interlocking functions and controls as outlined in the specifications. If the standard terminals supplied by the Electrical Division require supplementation in any way, e.g. by supplying additional N.O. or N.C. contacts, these facilities are included in the Mechanical Division scope.

.5 Mechanical Division shall provide the mechanical control consoles complete with pilot controls, indicating lights, etc. as outlined in the specifications.

.6 When an item provided under the Mechanical Division is factory supplied with a starter or contactor and it is necessary to alter or add to the control wiring in order to achieve the method of operation specified in the Mechanical Division, this work shall be included in Mechanical Division.

.7 When control items such as thermostats, float controllers, etc., are connected to power wiring in series with the item being powered (e.g. unit heater motor, fractional HP fans, etc.), the supply and installation of

the controller devices are included in Mechanical Division. Power wiring to and from the controllers is included in the Electrical Division. Install line voltage thermostats for single phase motors provided by the Mechanical Division where specifically indicated on the drawings and/or the "Equipment Schedule" of this specification.

.8 When the electrical characteristics of a controlled item exceed the capacity of a specified controller, provision of a contactor and the required wiring shall be included in the Mechanical Division.

1.5 ELECTRICAL DIVISION RESPONSIBILITIES FOR PLUMBING DIVISIONS

.1 When a drive, motor, etc. provided under the Plumbing Divisions is factory supplied with a starter, contactor, alternator, pressure switch, etc., the wiring and installation of these items and controls shall be included in the Electrical Division.

.2 The ten point terminal blocks similar to those specified under the Mechanical Division controls are not mandatory for the Plumbing Division equipment.

.3 The Electrical Division shall provide stop/start or HOA controls as specified for each item except where these stations are factory supplied with equipment.

.4 The Electrical Division shall leave each system fully functional and requiring only minor final adjustments (such as pressure or vacuum settings) by the Plumbing Divisions.

Part 2 Products

2.1 MATERIALS

.1 Refer to appropriate section of the Electrical Division(s).

2.2 CONTROL RELAYS

.1 Control relays to be rated minimum 10 A, 300V, with contacts as required and 120 V control coil unless otherwise noted. Relays to be typically mounted in CEMA1 enclosures located in control terminal cabinets and/or MCC.

.2 Provide required fire alarm relays and auxiliary contacts in motor control centres or at the related equipment cabinets to provide activation and deactivation of mechanical fan units as specified in the Mechanical Division.

.3 Relays for fire alarm shutdown system control to be approved for fire alarm use and powered from the fire alarm panel. Fire alarm relay enclosures to be finished in red and identified "FIRE ALARM RELAY".

.4 Time delay relays to incorporate time delay feature to delay either opening or closing as specified. Time period to be adjustable from 0 to 5 minutes unless otherwise specified.

Part 3 Execution

3.1 INSTALLATION

.1 Provide all labour and materials required to complete power wiring for HVAC, plumbing and fire protection equipment as called for in the project specifications and/or shown on the drawings.

.2 Provide all single- and 3-phase motor protection switches, combination starters and disconnects contactors and relays as required for mechanical equipment unless otherwise specifically noted in these specifications or on the drawings.

.3 Terminate all line voltage wiring to the designated equipment terminals.

.4 Obtain a full set of HVAC control shop drawings and have a full understanding of the scope before commencing installation and including any fire alarm interface.

.5 Verify the recommended overcurrent protection and rating of mechanical and plumbing and fire protection equipment and equipment supplied by other divisions. Change feeder overcurrent protection as required to comply with equipment recommendations. Notify the Departmental Representative of all revisions.

3.2 FIELD QUALITY CONTROL

.1 Cooperate with Mechanical Departmental Representative and Contractors and check out the operation of all motor controls with all HVAC and plumbing systems fully operational. Record all electrical loads. Replace any defective or wrongly sized starter overloads, heaters, fuses or circuit breakers.

END OF SECTION

Part 1 General

1.1 RELATED WORK

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

1.2 PRODUCT DATA

.1 Submit product data in accordance with Section 26 05 00 and 01 33 00.

Part 2 Products

2.1 DISCONNECT EQUIPMENT

.1 "Heavy Duty" class, enclosed manual air break switches in non-hazardous locations: to CSA C22.2 No.4

.2 Fuseholder assemblies to CSA C22.2 No.39.

.3 Fusible and non-fusible disconnect switch in CSA enclosure.

.4 Provision for padlocking in off switch position.

.5 Fuses as indicated. Allow for Class J or L for general circuits, Class RK5 for transformer, motor or other high inrush current circuits

.6 Fuseholders in each switch suitable without adaptors, for type of fuse as indicated.

.7 Quick-make, quick-break action.

.8 ON-OFF switch position indication on switch enclosure cover.

.9 Weatherproof as required.

2.2 CONTACTOR EQUIPMENT

.1 Contactors: to CSA C22.2 No.14.

.2 Half size contactors not accepted.

.3 Electrically operated, electrically or mechanically held, multi-pole full voltage type.

.4 Contactors to have 120V operating (and unlatching) coils unless otherwise noted.

.5 Controlled by pilot devices as indicated and rated for type of load controlled.

.6 Breaker or fused switch combination contactor as indicated.

.7 Complete with one normally open and one normally closed auxiliary contacts unless indicated otherwise.

.8 Provide CEMA enclosure as required for location unless indicated otherwise.

2.3 EQUIPMENT IDENTIFICATION

.1 Indicate name of load controlled on size 4 name plates to Section 26 05 00.

2.4 STANDARD OF ACCEPTANCE

.1 Cutler Hammer, or equivalent

.2 Schneider, or equivalent

.3 Siemens, or equivalent

Part 3 Execution

3.1 DISCONNECT INSTALLATION

.1 Install disconnect switches complete with fuses where indicated or required.

.2 Provide and locate safety disconnect switches to isolate individual items of equipment in accordance with Canadian Electrical Code CSA 22.1 whether indicated on not on the contract drawings.

3.2 MOTOR PLUG/RECEPTACLE AND QUICK DISCONNECTS

.1 Motor quick disconnects do not negate the requirement for a switched safety disconnect as specified in this Division. A separate disconnect is still required unless the Departmental Representative has given a special pre-approved circumstance.

3.3 CONTACTOR INSTALLATION

.1 Install contactors and connect auxiliary control devices.

.2 Pilot lights to be illuminated when contactor is closed.

.3 Control wire to be minimum #14 AWG. Remote control wiring to be 5A fuse protected and the wiring shall be upsized to limit voltage drop to no more than 2%.

.4 Control circuits shall fail safe leaving the contactor in the open position if the power fails or where automatic reset could be a safety or operational concern. Provide a control circuit seal-in contact for all momentary contact control devices unless otherwise indicated.

.5 The contactor shall not automatically reset after a power failure unless otherwise indicated or for such items as automatic freeze protection, snow melting, light control etc.

.6 Electrically held contactors to be located in service rooms where practical.

END OF SECTION

TABLE OF CONTENTS

1.1 EF 100 Checklist – Submissions to Departmental Representative

ITEM	CHECKED BY	DATE
5 WORKING DAYS BEFORE CLOSE OF SUBTRADE TENDER – Request for addition of acceptable manufacturers		
10 DAYS AFTER AWARD OF THE CONTRACT – List of equipment suppliers and subtrades (EF 110) – Detailed price breakdown (EF 112)		
A.S.A.P. – Shop drawings and Product Samples (EF 111)		
WITH EACH APPLICATION FOR PROGRESS PAYMENT – Price breakdown (EF 112)		
PRIOR TO DEMONSTRATION OF SYSTEMS – Demonstration agenda		
DEMONSTRATION OF SYSTEMS – Checklists for sign off of Demonstrations (EF 141)		
10 DAYS PRIOR TO SUBSTANTIAL PERFORMANCE – Submission of items listed on Form EF-142		
WHEN REQUESTING REVIEW OF OUTSTANDING WORK – Checklist of work remaining (EF 144) – Certificate of total completion (EF 145)		

1.2 EF 110 Equipment/Sub-Trade List

ITEM	COMPANY/SUPPLIER
Breakers	
Motor Control	
Wiring Devices	
Seismic Engineer	
Testing and Commission Agency	
Other	
Other	
Other	

Modify/Add to suit project and equipment responsibility splits

1.3 EF 111 Checklist –Shop drawings and Product and Samples

		REVIEW	
ITEM	**DATE SUBMITTED**	**ACTION**	**DATE**
Breakers			
Motor Control			
Wiring Devices			

NOTES:

.1 Modify list to suit project.

.2 Submit samples where indicated to the Departmental Representative for review prior to installation.

1.4 EF 130 Certificate of Penetrations Through Separations

Project Identification: _____

I hereby declare that I _____

am an employee/a principal of _____

have personally witnessed that all electrical service penetrations through fire separations (rated & non-rated) and sound separations in the following areas have been properly sealed in accordance with the specified requirements.

SIGNED _____ DATE _____

AREA	SIGNED	DATE
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		
Level:		

NOTES:

.1 This certificate shall be submitted to the Departmental Representative prior to Substantial Performance.

1.5 EF 131 Certificate of Seismic Restraint Installation

Project Identification: _____

I hereby declare that I _____

am an employee/a principal of _____

Certify that the seismic restraint of all electrical equipment and wiring system installation meets the requirements of the Vancouver Building By-Law as it relates to seismic restraint and the Schedules B, B1 & CB have been submitted and signed and to the Departmental Representative.

SIGNED _____ DATE _____

NOTES:

.1 This certificate shall be submitted to the Departmental Representative prior to Substantial Performance

1.6 EF 132 Certificate of Acoustic and Vibration Isolation

Project Identification: _____

I hereby declare that I _____

am an employee/a principal of _____

Certify that the vibration isolation installation for the Electrical Equipment has been satisfactorily completed.

SIGNED _____ DATE _____

NOTES:

.1 This certificate shall be submitted to the Departmental Representative prior to Substantial Performance

1.7 EF 140 Checklist & Record – Items to be Handed to Departmental Representative

ITEM	QUANTITY	RECEIVED	DATE
Motor Starter HOA selector switch	2		
Motor Starter Pilot lights	10		
Motor Starter Operating coil for each size starter	2		
Motor Starter Control fuses	5 of ea		
Motor Starter Power fuses	3 of ea		
Salvaged Materials (Attach List)			

NOTES:

.1 Copies of this form shall be submitted to the Departmental Representative with all items signed off prior to substantial performance.

Prepared By _____

Departmental Representative's Sign Off _____ DATE _____

1.8 EF 141 Checklist – Demonstration to Departmental Representative

	CONTRACTOR		DEPARTMENTAL REPRESENTATIVE	
SYSTEM/ITEM	**SIGNED**	**DATE**	**SIGNED**	**DATE**
Motor Control Operation				
Emergency Power Systems				
Location of Control Devices				
Access to Equipment				
Review of Maintenance Manual				
Points of Required Maintenance				

NOTES:

.1 Contractor shall submit copies of this form with each appropriate item signed and dated by the person having overall charge of commissioning prior to substantial performance. (See **EF 143**).

.2 Departmental Representative shall sign off each item during or after the demonstration.

.3 Contractor to strike out items where they do not apply to the systems being demonstrated.

.4 Interlocks and controls to be demonstrated by following the descriptions and diagrams in the contract documents and proving that all controls function as required.

.5 Where multiple identical controls are installed the Departmental representative may elect to only witness sample items, but the person having charge of commissioning is expected to have checked them all.

1.9 EF 142 Checklist – Substantial Performance Submissions - Electrical

SECTION	ITEM	DATE	STATUS
260500	Final Electrical Inspector Certificate		
260500	Fire Stop Penetration Certificate. (**EF-130**)		
260500	Acoustic & Vibration Isolation Certificate. (**EF-132**)		
260500	Items handed to Departmental Representative Checklist (**EF 140**)		
260500	Identification		
260500	Record Drawings		
260500	Operating & Maintenance Manuals		
260505	Seismic Engineer Report and Schedules (**EF131**)		
	Contractors Letter of Guarantee		
	Demonstration to Operating Staff agenda		
	Demonstrations Checklists (**EF 141**)		
	Substantial Performance Certificate (**EF143**)		
	Checklist of work remaining after Substantial (**EF 144**).		

NOTES:

.1 This list is provided as a typical checklist and may not include all Substantial Performance requirements. Contractor to update as required.

1.10 EF 143 Certificate of Substantial Performance - Electrical

I hereby certify that I _____
am an employee / a principal / an agent

of _____

and have personally witnessed the following with regard to the electrical systems work specified for the above project and that to the best of my knowledge except as noted on **EF 144** (attached);

- The installation is complete and as specified.
- The systems have been commissioned and operate satisfactorily.
- Every control sequence and every control performs as specified.
- The systems are clean.
- All of the required submissions have been made to the Departmental Representative.

SIGNED _____ DATE _____

NOTES:

.1 This certificate must be completed and submitted to the Departmental Representative prior to substantial performance.

.2 If it is apparent that the systems or their operation are seriously deficient then all reasonable costs and Departmental Representative time charges relating to any subsequent site reviews shall be deducted from the contract sum.

1.11 EF 144 Checklist – Work Remaining After Substantial Performance

		COMPLETION		
ITEM NO.	**DESCRIPTION**	**CLAIMED BY**	**DATE**	**VERIFIED DATE**

NOTES:

.1 This form must be filled in and submitted to the Departmental Representative prior to substantial performance.

.2 Any discovered outstanding items will be added to the list by the Departmental Representative. Copies of the complete list will be circulated to the Departmental Representative, the Architect and the Contractor.

.3 The Contractor may include estimated values against the outstanding work but determination of the actual amounts to be held will be made by the Departmental Representative.

.4 The Contractor shall sign off each item as it is completed and submit the list monthly to the Departmental Representative. When all items are signed off the completed list shall be submitted with the certificate of total performance **EF 145**.

1.12 EF 145 Certificate of Total Performance – Electrical

I hereby certify that I _____
am an employee / a principal / an agent

of _____

and have personally witnessed that each item of outstanding work on the checklist and record of work remaining after substantial completion EF 144 (attached) has been satisfactorily completed and I hereby certify that the Electrical systems work specified on the above project is complete.

SIGNED _____ DATE _____

NOTES:

.1 This certificate must be completed and submitted to the Departmental Representative when requesting total performance.

.2 If it is apparent during the final review that the systems or their operation are seriously deficient then all reasonable costs and Departmental Representative time charges relating to any subsequent site reviews shall be deducted from the contract sum.

END OF SECTION

APPENDIX

Hazardous Building Materials Assessment

POD 2 Boiler Room, Mechanical Room and Select Portions of the Roof,
Kent Institution, Agassiz, BC

January 22, 2018

Project No.:651548

Prepared For:

Public Services Procurement Canada (PSPC)

Prepared By:

M. Aaron Hall, B.Sc., A.Sc.T.
Project Scientist

Environment & Geoscience
Infrastructure

Reviewed By:

Tim Drozda, P.Eng.
Environmental Scientist

Environment & Geoscience
Infrastructure

SNC·LAVALIN

Executive Summary

On behalf of Public Services Procurement Canada (PSPC) for Correctional Services Canada (CSC), SNC-Lavalin Inc. (SNC-Lavalin) has completed a pre-renovation destructive hazardous building materials assessment (HBMA) of the POD 2 building boiler room (#3801) and mechanical room (#3800) at the Kent Institution located at 4732 Cemetery Road in Agassiz, BC (the "Site"). Selected portions of the roof were also included in the HBMA. SNC-Lavalin understands that the building was constructed in 2012 and the purpose of the work was to identify potential materials of concern in preparation for future upgrades.

On December 19, 2017, SNC-Lavalin completed a destructive HBMA of the POD 2 building boiler and mechanical rooms and roof (collectively, the "Assessed Areas") to identify potential materials of concern in preparation for future renovations. The Assessed Areas were observed for the potential existence of hazardous materials including: asbestos, lead-containing paint, polychlorinated biphenyls (PCBs), mercury, radiological sources and/or substances, silica, biological hazards, and mould and/or moisture. This assessment report provides the analytical results of materials sampled by SNC-Lavalin.

Based on the results of the HBMA, there are hazardous building materials within the Assessed Areas requiring specific procedures prior to deconstruction/renovation for: handling; abatement; demolition; and disposal.

Summary of Findings

The results of the HBMA are summarized in the following table.

Hazardous Material	Description and Location
ACMs	*Potential ACMs NOT Sampled* › Multiple fire doors and frames, each with potentially asbestos-containing filler material, were observed in the Assessed Areas. › Underground asbestos-containing cement pipes may be present at the Site. The identification of potential ACMs below ground was not within the scope of this report, and should be addressed during any excavation at the Site.
Lead-Containing Paints	*Current Assessment Lead-Containing Paints* › Teal green, valve assembly on the two boilers located in the Boiler Room.
PCBs	› Approximately 18 fluorescent light fixtures with potentially PCB-containing ballasts were identified throughout the area assessed.
Mercury	› No suspect liquid mercury was observed in the assessed areas. › Fluorescent light tubes (assumed to contain mercury vapour) were observed throughout the areas assessed in conjunction with potentially PCB-containing fluorescent light fixtures or stored within the Assessed Areas.
Ozone-Depleting Substances	› Two heat exchangers were observed in the Boiler Room. One had a sign indicating that it was out of service.
Radiological Sources and/or Substances	› Heat detectors, each with an assumed radiological source, were identified in the Mechanical Room.
Miscellaneous Solid and Liquid Wastes	› A tank labelled "Glycol Tank" was identified amongst the equipment in the Boiler Room. › Two empty pails labelled "glycols" were identified in the Boiler Room. › Potentially lead-containing solder on copper piping.

Hazardous Material	Description and Location
Silica	› Concrete floors were identified throughout the Boiler and Mechanical Rooms. › Drywall and drywall joint compound were identified on the walls of the Boiler Room. › Cinder block and mortar walls or concrete walls are assumed to be located behind the drywall walls as these were observed in adjacent areas of the building.
Biohazardous Materials	› No suspect biohazardous materials were observed in the Assessed Areas.
Mould and/or Moisture	› No mould was observed in the Assessed Areas. › Evidence of historical water presence (rust stains) was observed on the floor of the Boiler Room. › Water was observed dripping from a pipe associated with the boiler unit nearest the entrance to the Boiler Room.

The following should be noted:

› All materials found in the Assessed Areas of similar colours as identified above as lead-containing paint should be considered as lead-containing.

Recommendations

A detailed summary and recommendations for the management of each hazardous material identified is presented in Table 1 of Section 5; results are included in Appendix I.

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1 Introduction

On behalf of Public Services Procurement Canada (PSPC) for Correctional Service Canada (CSC), SNC-Lavalin Inc. (SNC-Lavalin) completed a pre-renovation destructive hazardous building materials assessment (HBMA) of the POD 2 building boiler room (#3801) and mechanical room (#3800) at the Kent Institution located at 4732 Cemetery Road, Agassiz, BC. Selected portions of the roof were also included in the HBMA. SNC-Lavalin understands that the purpose of the work was to complete a destructive HBMA of the POD 2 boiler room, mechanical room, and selected portions of the roof (collectively, the "Assessed Areas") to identify potential materials of concern prior to planned renovation activities. SNC-Lavalin understands that the building was constructed in 2012.

The PSPC project number for this work is as follows:

- Project Number R.087167.001 – POD2 Building Boiler and Mechanical Rooms (2012).

All work was completed as per the *Hazardous Materials Assessment Consulting Services Task Authorization – EZ113-150642/003/PWY* under Task Authorization No. 700397422.

2 Scope of Work and Methodology

On December 19, 2017, SNC-Lavalin personnel observed the Assessed Areas of the POD 2 building at the Site to identify the potential existence of the following hazardous materials:

- asbestos;
- lead-containing paint;
- polychlorinated biphenyls (PCBs);
- ozone-depleting substances (ODS);
- miscellaneous solid and liquid wastes;
- mercury containing equipment;
- radiological sources and/or substances;
- silica;
- biological hazards (e.g., rodent faeces); and
- mould and/or moisture.

It should be noted that the following materials were excluded from the proposed scope of work for the HBMA: formaldehyde; carbon monoxide; radon; volatile organic compounds; very-short-lived low-level radioactive waste; and, indoor air quality pollutants.

Representative samples were collected and laboratory analysis completed for suspected asbestos-containing materials (ACMs) and lead-containing paints.

The following sections outline the specific protocols followed when completing the survey.

Asbestos

The methodology for completing the asbestos assessment was in accordance with WorkSafeBC guidelines and included the identification of suspect materials and collection of an adequate number of representative samples of these materials. All accessible portions of the Assessed Areas were observed for possible ACMs. Wall cavities were inspected for the possible presence of vermiculite insulation via pre-existing perforations.

On December 19, 2017, a total of 18 samples were collected from the Assessed Areas. All samples were submitted for asbestos analysis to Maxxam Analytics of Burnaby, BC (Maxxam) and analyzed in accordance with the applicable regulations. The requested detection limit was < 0.5%, as per WorkSafeBC requirements. The analysis method for asbestos used was polarized light microscopy (PLM). Maxxam's scope of accreditation includes EPA-600/M4-82-020: "Interim Method for the Determination of Asbestos in Bulk Insulation Samples" and EPA-600/R-93/116: "Method for the Determination of Asbestos in Bulk Building Materials". Maxxam is accredited through the National Voluntary Laboratory Accreditation Program (NVLAP) for bulk asbestos analyses.

Lead Paint

Different paint colours may contain different concentrations of lead; therefore, SNC-Lavalin personnel inspected the Assessed Areas to determine primary paint colour(s) that had been applied to major surfaces. The approach was to try to obtain samples from structures that may need to be cut or ground during renovations. Factory painted metal surfaces are not sampled as the paint is applied in thin layers, making it difficult to obtain a sufficient amount of paint to analyze.

On December 19, 2017, a total of 11 samples were collected from the Assessed Areas. Samples were submitted to Maxxam for analysis of total lead in accordance with the applicable regulations. Maxxam is accredited for both lead in paint and leachable lead through the Canadian Association for Laboratory Accreditation Inc. (CALA).

PCBs

Historical use of PCBs in electrical equipment manufactured in Canada, such as transformers, fluorescent lamp ballasts, and capacitors, was common prior to approximately 1977. The use of PCBs was prohibited by the Canadian Environmental Protection Act in heat transfer and electrical equipment installed after August 1977, and in transformers and capacitors installed after June 1980. However, experience has shown that electrical equipment manufactured previously and held in inventory may still be in use.

The survey included the observation of accessible portions of the Assessed Area for items or equipment that could possibly contain PCBs, such as fluorescent light fixtures, high intensity discharge (HID) lamps, and oil-filled electrical equipment.

SNC-Lavalin personnel identified (where possible) fluorescent light ballasts and noted the manufacturer and/or date codes on the ballast labels. These were compared to the Environment Canada publication, "Identification of Lamp Ballasts Containing PCBs, Report EPS 2/CC/2" (August 1991) to determine if they contain or are suspected of containing PCBs.

Ozone Depleting Substances

The interior and exterior spaces of the Assessed Areas were observed to identify if air conditioning units, refrigerators, freezers, or other ODS were present in the equipment identified. If units were identified, the manufacturer's nameplate (if accessible) was observed to determine the type and amount of ODS present in the unit.

Miscellaneous Solid and Liquid Wastes

The accessible interior and exterior areas of the Assessed Areas were observed for solid and/or liquid wastes and, if found, SNC-Lavalin compiled an inventory of these potentially hazardous materials. If encountered, aboveground storage tanks were photographed and assessed for volume, content, year of manufacture, and overall condition. It is assumed that the prior to demolition/deconstruction the majority of these materials will be removed. Any remaining hazardous materials should be properly disposed of by a qualified contractor prior to demolition/deconstruction.

Mercury

Mercury has widespread use in commercial/residential products including fluorescent light tubes, HID lights (mercury vapour / high pressure sodium and metal halide), electrical switches, barometers, and thermometers. It also has many commercial, medical, and industrial applications. A potential concern of mercury is persistence in the environment when released at a landfill following disposal. Special considerations must be taken during the disposal of items containing mercury.

The Assessed Areas were observed for thermostats that may contain small amounts of liquid mercury and/or mercury vapour. The covers of thermostats found were opened to assess the presence of ampoules containing liquid mercury.

Radiological Sources and/or Substances

Radioactive sources and/or substances may be present in smoke detection devices.

All accessible portions of the Assessed Areas were observed for potential radiological sources and/or substances and, if found, SNC-Lavalin compiled an inventory. Any remaining radiological sources and/or substances should be properly disposed of by a qualified contractor prior to demolition/deconstruction.

Silica

Silica occurs naturally as a crystalline material in rock, sand, concrete, and cement; therefore, is likely present in poured concrete slabs/floors, concrete blocks, mortar, plaster, drywall, acoustic ceiling tiles, and ceramic tiles. Crystalline silica is significantly more toxic than amorphous silica; however, both are regulated. Crystalline silica dust can be generated through processes such as breaking, drilling, hammering, blasting, grinding, crushing, or sandblasting silica-containing materials. When breathed in, the crystalline silica dust can cause permanent damage to the lungs.

SNC-Lavalin personnel noted the presence of materials in the Assessed Areas that are suspected of containing silica.

Biological Hazards

SNC-Lavalin personnel observed all accessible portions of the Assessed Areas for the presence of biological hazards. Any suspect hazards identified were noted and photographed.

Mould and/or Moisture

SNC-Lavalin personnel observed all accessible portions of the Assessed Areas for the presence of mould and/or moisture. Any suspect areas identified (e.g., beneath sinks or adjacent hot water tanks) were noted and areas of concern were photographed.

3 Regulatory Framework

Federal and provincial regulations require that hazardous building materials be properly identified and managed to prevent potential exposure to workers. In addition, a more intrusive survey is required to identify materials of concern prior to renovations, salvage, or demolition of a building or structure. These materials must be properly controlled, removed, and/or disposed of at a suitably permitted facility in accordance with the applicable federal and provincial regulations. The following federal and provincial regulations relate to these materials:

Federal

Various Regulations made under the Canadian Environmental Protection Act (CEPA), 1999, S.C. 1999, c. 33, last amended on June 17, 2016, including specialized handling and/or disposal requirements for materials including lead, PCBs, mercury, halocarbons (ODS and Non-ODS), radiological sources and/or substances and solid/hazardous wastes. Regulations include the following:

- *Federal Halocarbon Regulations*, 2003 (SOR/2003-289) and Regulations Amending the Federal Halocarbon Regulations, 2003 (SOR/2009-221) defines the use and handling of halocarbons (including ODS) in refrigeration, air-conditioning, fire-extinguishing and solvent systems that are located on federal lands, or are owned by federal departments, boards and agencies, Crown corporations or federal works and undertakings.
- *Ozone-Depleting Substances and Halocarbon Alternatives Regulations* (SOR/2016-137) defines the import, export, manufacture, use, sale and offer for sale of ODS.
- *PCB Regulations* (SOR/2008-273), last amended on January 1, 2015, defines PCB containing materials, how they must be managed and disposed of.
- *Transportation of Dangerous Goods Act* (TDG)*, enacted 1992, c. 34, last amended on January 1, 2017*, Transportation of Dangerous Goods Regulations (SOR/2001-286), as amended, requires that radioactive materials must be transported in accordance with the provisions of the Act.
- *Hazardous Products Act* (R.S.C., 198, c. H-3), as amended up to December 12, 2016, prohibits the sale or importation of urea formaldehyde foam insulation (UFFI) into Canada.
- *Surface Coating Materials Regulations,* SOR/2005-109, as amended up to June 22, 2016, requires the concentration of total lead present in a surface coating material to be not more than 90 mg/kg.
- *Human Resources Social Development Canada* (HRSDC)*, Canada Labour Code Part II*, Canada Occupational Health and Safety Regulations, Part X, Hazardous Substances, as amended, requires that all hazardous substances in the workplace, including asbestos, be identified and controlled to minimize potential exposure to workers. Under the Canada Labour Code Part II definitions, a “hazardous substance” includes a controlled product and a chemical, biological, or physical agent that, by reason of a property that the agent possess, is hazardous to the safety or health of a person exposed to it.
- *Mould Guidelines for the Canadian Construction Industry* - CCA82, Canadian Construction Association, 2004, provides guidance on minimizing and abating mould growth.
- *The Nuclear Safety and Control Act* (1997, c.9), Nuclear Substances and Radiation Devices Regulations (SOR/2000-207) applies to nuclear substances and sealed sources, including devices such as smoke detectors.

Provincial

- *WorkSafeBC Occupational Health and Safety Regulation* (OHSR), BC Reg. 296/97, includes amendments up to B.C. Reg. 142/2017, August 1, 2017, requires that materials including any asbestos, lead, or other heavy metal or toxic substance, biological agents (i.e., rodent droppings), and flammable or explosive materials that may be handled, disturbed or removed during demolition must be identified and removed or safely contained prior to demolition. In addition, a copy of the observation report identifying these materials must be available at the work site. The requirements for the management of indoor air quality are also included.
- *Environmental Management Act* (EMA), B.C. Reg. 179/2016 / July 19, 2016, *Ozone Depleting Substances* (ODS) *and Other Halocarbons Regulation*, BC Reg. 387/99, including amendments up to BC Reg. 317/2012, requires ODS to be recovered from equipment prior to disposal.
- *Hazardous Waste Regulation* (HWR), B.C. Reg. 63/88, including amendments up to B.C. Reg. 179/2016, requires all Hazardous Wastes (HW) must be properly managed and disposed of.

Asbestos

We note that at the time of this report, the provincial OHSR defines ACM as any manufactured article or other material which contains 0.5% or more asbestos by weight and vermiculite insulation containing any amount of asbestos.

Lead Paint

Federal and provincial guidelines limit lead concentrations in paint to 90 mg/kg for high risk individuals (i.e., pregnant women and children), and any concentrations that exceed this limit would be considered a lead-containing paint. WorkSafeBC suggests that improper removal of lead-containing paint can result in airborne lead concentrations that exceed 50% of the airborne lead exposure limit of 0.05 mg/m^3; this would trigger the requirement for an employer to file a Notice of Project Lead (NOPL) and the development and implementation of an exposure control plan and safe work procedures prior to any work being completed. Therefore, for the purposes of this report we have identified paint as lead-containing if the total lead concentration is >90 mg/kg as per the federal regulations. An exposure control plan may be required if the paint is disturbed in such a manner that workers could be exposed to lead at >50% of the exposure limit.

There are no special disposal requirements for materials coated with lead paint unless the lead is found to be leachable in excess of the regulated standard of 5 mg/L in the HW regulations while considering the entire mass of the object the paint is coating.

Radiological Sources and/or Substances

Radioactive materials are listed under the current Federal TDG Act. Substances with a specific radioactivity greater than 70 kBq/kg are considered Class 7 (Radioactive Materials) within the TDG Act and must be transported in accordance with the provisions of the TDG Act. The Nuclear Safety and Control Act (1997, c.9), Nuclear Substances and Radiation Devices Regulations (SOR/2000-207), advises that radioactive substances that do not contain more than 185 kBq of americium 241 or, where it is in a commercial or industrial facility, more than 740 kBq of americium 241, are not considered as a radioactive source under the TDG Act. However, large quantities of smoke detectors stored and transported together may be considered as a radioactive source. Standard residential smoke detectors contain an estimated 37 kBq of americium 241.

Silica

WorkSafeBC indicates that employers are required under Section 5.54 of the OHSR to develop an exposure control plan when workers are or may be exposed to airborne silica dust in excess of 50% of the exposure limit. Exposure limits vary depending on the type of silica identified.

Biological Hazards

WorkSafeBC indicates that employers are required under Part 6 of the OHSR to develop an exposure control plan when it is reasonable to expect workers could be exposed to birds (or their droppings) and/or rodents (or their saliva, urine, or droppings) as part of their normal job duties. The OHSR requires the development and implementation of an exposure control plan that eliminates or minimizes the specific risks and hazards in their workplace. Recommendations for exposure control plans and work procedures for the identification and clean-up of rodent-contaminated areas are outlined in WorkSafeBC's 2006 publication *A Hantavirus Exposure Control Program for Employers and Workers*[1].

Mould

WorkSafeBC outlines requirements for the management of indoor air quality under Sections 4.7 to 4.8 of the OHSR. WorkSafeBC has also developed an indoor air quality guideline (Part 4, Section G4.79 – *Moulds and Indoor Air Quality*) that outlines procedures for the assessment and abatement of mould impacted building materials in the workplace. Additionally, WorkSafeBC indicates that employers are required under Part 6 of the OHSR to develop and implement an exposure control plan when workers may be exposed to biological agents by any route of transmission.

Additional recommendations on how to minimize the presence of mould as well as abatement and remediation recommendations are contained within the *Mould Guidelines for the Canadian Construction Industry.* WorkSafeBC's 2005 publication *Indoor Air Quality: A Guide for Building Owners, Manager, and Occupants*[2] also provides recommendations for maintaining good indoor air quality in a workplace, preventing indoor air quality problems, and how to correct problems that may arise.

4 Results

Details of the results are presented for each hazardous material of concern in Table A, included as Appendix I. All suspect asbestos and lead paint samples were given the prefix "KENT-POD2-"; for conciseness, this prefix has been omitted in Table A.

[1] https://www.worksafebc.com/en/resources/health-safety/books-guides/a-hantavirus-exposure-control-program-for-employers-and-workers
[2] https://www.worksafebc.com/en/resources/health-safety/books-guides/indoor-air-quality-a-guide-for-building-owners-managers-and-occupants

5 Summary and Recommendations

Based on the results of the survey, there are hazardous building materials located on the Site requiring specific procedures prior to renovations for: handling; abatement; demolition; and disposal, as outlined below in Table 1. The sample locations are presented on Drawings 651548-BM01 and 651548-BM02, included as Appendix II. Select photographs of the general site layout, sample locations, and other observations of note are included in Appendix III (Photos 1 through 15). A copy of the laboratory analytical report for the asbestos and lead analyses is included in Appendix IV.

A summary of the hazardous building materials identified on Site is included in Table 1 below:

Table 1: Summary Table of Hazardous Building Materials Identified in the Assessed Areas of POD 2 – Kent Institution, Agassiz, BC

Description and Location	Recommendations
ASBESTOS-CONTAINING MATERIALS	
› None identified.	No pre-renovation requirements necessary.
Potential ACMs NOT Sampled › Fire doors were identified throughout the Boiler and Mechanical Rooms. The doors may contain asbestos-containing filler (Photo 1). › There is potential for underground asbestos-containing cement pipes at the Site. The identification of potential ACMs below ground was not within the scope of this report, and should be addressed during any excavation at the Site.	SNC-Lavalin understands that PSPC (for CSC) intends to complete renovations in the Assessed Areas; therefore, SNC-Lavalin recommends that all known and suspect ACMs identified be removed and disposed of by a qualified contractor in accordance with applicable federal and/or provincial regulations. All work should be completed in accordance with the Canada Labour Code [Sections 124(1)y and 125(1)Z.14], which is in place to protect any person accessing the work place. Control of exposure to asbestos is governed by the WorkSafeBC Occupational Health and Safety Regulation (OHSR), BC Reg. 296/97 (as amended) and the provincial Hazardous Waste Regulation. Additional guidance is provided in the WorkSafeBC publication *Safe Work Practices for Handling Asbestos*. If required, the abatement contractor should file a NOPA with WorkSafeBC prior to any asbestos abatement work taking place. Documentation should be provided by the abatement contractor and retained by CSC to verify compliance with the applicable regulations.

Table 1 (Cont'd): Summary Table of Hazardous Building Materials Identified in the Assessed Areas of POD 2 – Kent Institution, Agassiz, BC

Description and Location	Recommendations
LEAD-CONTAINING PAINTS	
Lead-Containing Paints › **Teal green**, on boiler valve assembly on each of the two boilers in the Boiler Room (Photo 2).	WorkSafeBC suggests that improper removal of lead-containing paint can result in airborne lead concentrations that exceed 50% of the airborne lead exposure limit of 0.05 mg/m^3; this would trigger the requirement for an employer to file a NOPL and the development and implementation of an exposure control plan and safe work procedures prior to any work being completed. If required, the abatement contractor should file a NOPL with WorkSafeBC prior to any lead abatement work taking place. Documentation should be provided by the abatement contractor and retained by CSC to verify compliance with the applicable regulations. The waste generated from removal of paint and surface coatings may be hazardous. Given the possible need for off-site disposal of waste material during deconstruction/renovation activities, laboratory analysis for preliminary waste characterization of select samples (concentrations of metals in the leachate) may be required. If leachate analysis (Toxicity Characteristic Leaching Procedure [TCLP]) is required for disposal of materials containing elevated lead concentrations, additional sampling may be required. All paints found at the Site of similar colours as those identified to be lead-containing paint should be considered lead-containing.
POLYCHLORINATED BIPHENYLS	
› **Approximately 18 fluorescent light fixtures containing potential PCB-containing ballasts** were identified throughout the Assessed Areas.	Prior to renovation/demolition, remove all light ballasts and/or capacitors. Inspect for PCB-containing and/or suspect PCB-containing ballasts as per Environment Canada publication, Identification of Lamp Ballasts Containing PCBs, Report EPS 2/CC/2, August 1991. Place known or suspect PCB-containing ballasts in an 18-gauge steel painted drum with a close fitting removable steel lid on top of a gasket of PCB-resistant material. Drums should be disposed of in Canada in accordance with the Hazardous Waste Regulation. A letter stating that PCBs disposal work was completed should be provided by the contractor and retained by CSC to verify compliance with the applicable regulations.

Table 1 (Cont'd): Summary Table of Hazardous Building Materials Identified in the Assessed Areas of POD 2 – Kent Institution, Agassiz, BC

Description and Location	Recommendations
OZONE DEPLETING SUBSTANCES	
› **R410A** is present in the operational heat exchanger located in the Boiler Room (Photo 3).	Non-ODS refrigerants (R410a) containing hydrofluorocarbons (HFC) are regulated in the Federal Halocarbon Regulations as per Table 4 in Schedule 1 – List of Halocarbons. As a result, halocarbon-containing Non-ODS refrigerants should be recovered by qualified personnel and disposed of in accordance with Federal Regulations.
MERCURY	
› No equipment suspected to contain liquid mercury were observed.	No pre-renovation requirements necessary.
› **Fluorescent light tubes** (assumed to contain mercury vapour) were observed throughout the Assessed Areas in conjunction with potential PCB-containing fluorescent and high intensity discharge light ballasts.	The fluorescent light tubes generated from renovation activities should be either recycled or disposed of in accordance with the requirements of the Hazardous Waste Regulation.
MISCELLANEOUS SOLID AND LIQUID WASTES	
› **One "Glycol Tank"** was identified amongst the equipment in the Boiler Room (Photo 4). › **Two empty pails labelled "glycols"** were identified in the Boiler Room (Photo 4). › **Potentially lead-containing solder** on copper piping (Photo 5).	If these materials are to be disposed of or recycled, it is the responsibility of the qualified contractor to correctly identify and characterize the wastes observed and dispose of or recycle appropriately.
RADIOACTIVE SOURCES / SUBSTANCES	
› **Heat detectors** with an assumed radiological source were observed in the Mechanical Room.	Substances with a specific radioactivity greater than 70 kBq/kg are considered Class 7 (Radioactive Materials) within the TDG Act and must be transported in accordance with the provisions of the TDG Act. The Nuclear Safety and Control Act (1997, c.9), Nuclear Substances and Radiation Devices Regulations (SOR/2000-207), advises that radioactive substances that contain more than 185 kBq of americium 241 or, where it is in a commercial or industrial facility, more than 740 kBq of americium 241, is considered as a radioactive source under the TDG Act. These materials must be removed prior to demolition. However, if these materials are to be disposed of or recycled, it is the responsibility of the qualified contractor to correctly identify and characterize the wastes observed and dispose of or recycle appropriately.

Table 1 (Cont'd): Summary Table of Hazardous Building Materials Identified in the Assessed Areas of POD 2 – Kent Institution, Agassiz, BC

Description and Location	Recommendations
SILICA	
› **Concrete floors** were identified throughout the Boiler and Mechanical Rooms. › **Cinder block and mortar or concrete walls** were identified in adjacent areas of POD2. It is assumed that the walls behind the drywall are either cinder block and mortar or concrete; however, this was not confirmed. › **Drywall and drywall joint compound** were identified on the walls in the Boiler and Mechanical Rooms.	Suspected silica-containing material, such as the concrete floor, must be managed appropriately. Parts 5, 6, and 20 of the OHSR set out occupational exposure guidelines and controls for silica dust to eliminate, reduce, or manage workers' exposure risk. WorkSafeBC identifies the requirement to develop an exposure control plan to protect workers from overexposure to airborne silica dust in excess of 50% of the exposure limit (i.e., crystalline silica has an OHSR occupational exposure limit of 0.025 mg/m^3).
BIOLOGICAL HAZARDS	
› No suspect biological hazards (e.g., rodent faeces) were identified.	No pre-renovation requirements necessary.
MOULD / MOISTURE	
› **Dripping water** was observed at one location; however, no mould was identified. › **Evidence of historical moisture presence** was observed (e.g., rust coloured stains on the floor); however, no mould was identified (Photo 1).	No pre-renovation requirements necessary.

- All relevant waste disposal documentation should be provided by the qualified contractors and retained by CSC.
- Site-specific work procedures for materials of concern should be provided by the qualified contractors and retained by CSC. Asbestos and lead procedures are included with NOPA and NOPL.

6 Notice to Reader

This report has been prepared by SNC-Lavalin Inc. (SNC-Lavalin) for Canada, who has been party to the development of the scope of work for this project and understands its limitations[3]. Copyright of this report vests with Her Majesty the Queen in Right of Canada. This report was prepared in accordance with a services contract between SNC-Lavalin and Canada, including General Conditions 2035 of the Standard Acquisition Clauses and Conditions (SACC) Manual.

This report is intended to provide information to Canada to assist it in making business decisions. SNC-Lavalin is not a party to the various considerations underlying the business decisions, and does not make recommendations regarding such business decisions.

The findings, conclusions and recommendations in this report have been developed in a manner consistent with the level of skill normally exercised by environmental professionals currently practising under similar conditions in the area. The findings contained in this report are based, in part, upon information provided by others. If any of the information is inaccurate, modifications to the findings, conclusions and recommendations may be necessary.

The findings, conclusions and recommendations presented by SNC-Lavalin in this report reflect SNC-Lavalin's best judgement based on the site conditions at the time of the site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. They have been prepared for specific application to this site and are based, in part, upon visual observation of the site and specific analysis of hazardous building material samples as described in this report. Substances other than those described may exist within the site, reported substance parameters may exist in areas of the site not investigated, and concentrations of substances greater or less than those reported may exist between sample locations.

The findings and conclusions of this report are valid only as of the date of this report. If site conditions change, new information is discovered, or unexpected site conditions are encountered in future work, including excavations, borings, or other studies, the findings, conclusions and/or recommendations of this report should be re-evaluated. It is recommended that users of this report should engage a suitably qualified professional to assist in interpreting the significance, if any, of the findings.

[3] © Her Majesty the Queen in Right of Canada (2018)

Appendix I

Results

Table A: Detailed Inventory of Hazardous Materials – Boiler Room, Mechanical Room, and Select Portions of the Roof of POD 2, Kent Institution, Agassiz, BC

Table A: Detailed Inventory of Hazardous Materials – Boiler Room, Mechanical Room, and Select Portions of the Roof of POD 2, Kent Institution, Agassiz, BC

Issue / Location	Results
ASBESTOS-CONTAINING MATERIALS (ACMs)	
Asbestos NOT Identified:	Analytical Result:
› A1, A2, & A3 – Roof, mastic, white, fall restraint anchor.	› non-asbestos
› A4, A5, & A6 – Roof, mastic, brown, between steel supports and roofing membrane.	› non-asbestos
› A7, A8, & A9 – Boiler Room, drywall compound, white.	› non-asbestos
› A10 – Boiler Room, mastic, off-white, pipe thread sealant, elbow to storage tank nearest door.	› non-asbestos
› A11 – Boiler Room, mastic, off-white, pipe thread sealant, blue boiler furthest from door.	› non-asbestos
› A12 – Boiler Room, mastic, off-white, pipe thread sealant, cold water piping.	› non-asbestos
› A13 – Boiler Room, gasket, off-white with green backing, near pump labelled P1.	› non-asbestos
› A14 – Boiler Room, gasket, off-white with green backing, blue boiler piping.	› non-asbestos
› A15 – Boiler Room, gasket, red, hot water storage tank nearest door.	› non-asbestos
› A16, A17, & A18 – Mechanical Room, plaster, white, sealant on end of insulation run.	› non-asbestos
Suspect ACMs not sampled:	Analytical Result:
› No wall perforations which extended into a cinder block wall were identified. Insulation behind the drywall was fibreglass.	› N/A
› The access door and frame to the boiler room are fire-rated. The door and/or frame may contain asbestos-containing filler material.	
› Access doors and frames into the Mechanical Room are fire rated. The doors and/or frames may contain asbestos-containing filler material.	
› There is potential for underground asbestos-containing cement pipes at the Site. The identification of potential ACMs below ground was not within the scope of this report, and should be addressed during any excavation at the Site.	
LEAD PAINT (mg/kg)	
Suspect Lead-Containing Paint Sampled:	Analytical Result:
› P1 – Roof, brown, grey beneath, steel girder.	› 18.9 mg/kg
› P2 – Roof, grey, brown beneath, steel gooseneck piping.	› < 9.0 mg/kg
› P3 – Boiler Room, grey, flooring.	› < 12 mg/kg
› P4 – Boiler Room, yellow, drywall walls.	› < 15 mg/kg
› P5 – Boiler Room, greyish brown, door frame.	› < 15 mg/kg
› P6 – Boiler Room, dark red, hot water storage tank.	› 36 mg/kg
› P7 – Boiler Room, light brown, entry doors.	› < 12 mg/kg
› P8 – Boiler Room, red, pump labelled P1CHW.	› 19 mg/kg
› **P9 – Boiler Room, teal green, boiler valve assembly.**	› **1,180 mg/kg**
› P10 – Mechanical Room, white, ceiling.	› < 12 mg/kg
› P11 – Mechanical Room, red, hot water relief tank.	› < 15 mg/kg

* **Bold** asbestos samples indicate asbestos content greater than or equal to 0.5%.
***** **Bold** lead paint samples indicate lead content greater than 90 mg/kg.

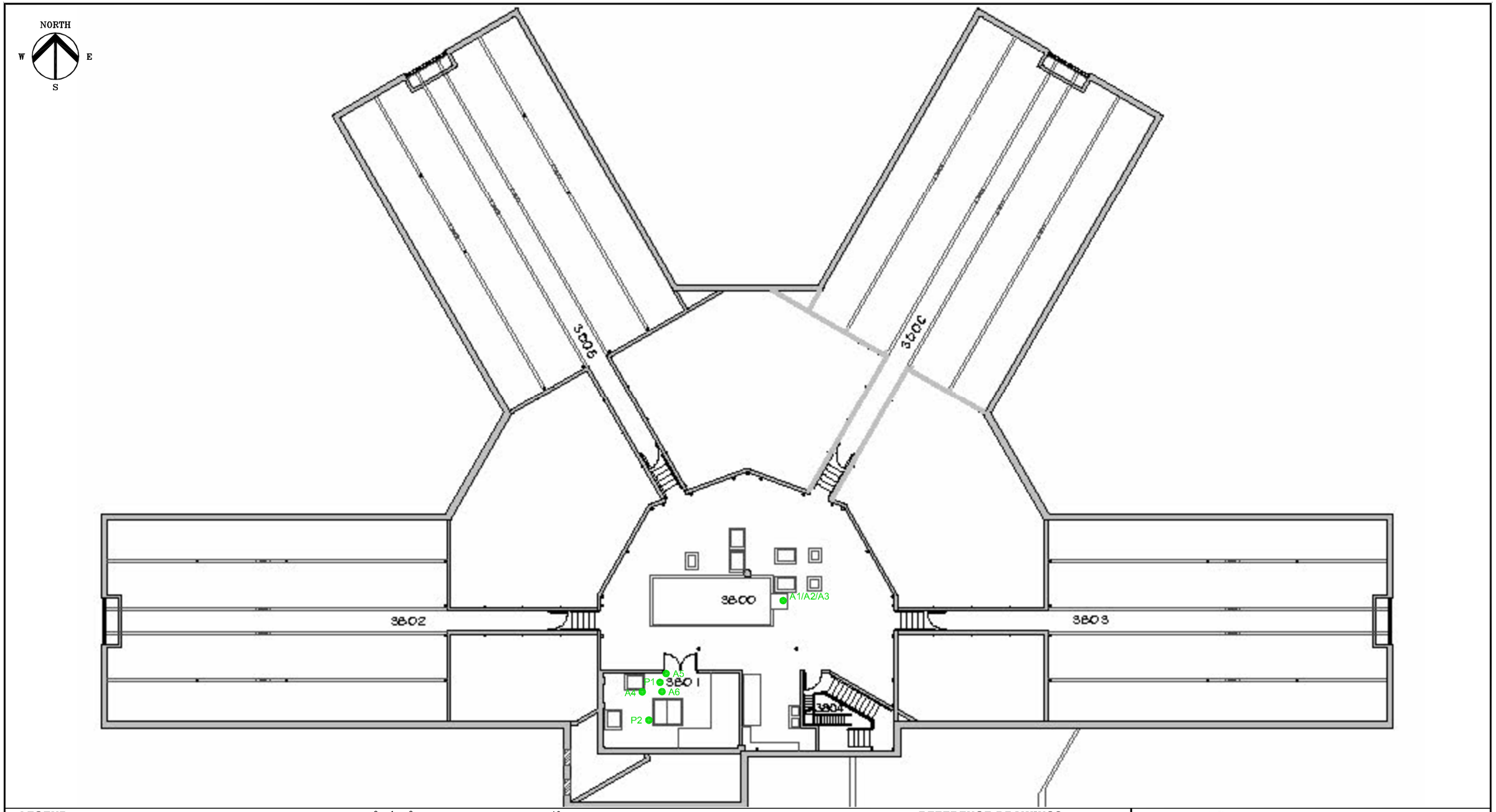
Table A (Cont'd): Detailed Inventory of Hazardous Materials – Boiler Room, Mechanical Room, and Select Portions of the Roof of POD 2, Kent Institution, Agassiz, BC

Issue / Location	Results
MISCELLANEOUS SOLID AND LIQUID WASTES	
An assumed glycol storage tank (labelled as "Glycol Tank") was identified in the Boiler Room.	› **Potential for liquid waste.**
Solder, potentially containing lead, was identified in the Boiler and Mechanical Rooms.	› **Potential for lead-containing material.**
Two empty 20 L pails, assumed to formerly contain glycols (labelled "Glycol") were observed in the Boiler Room.	› **Potential for liquid waste.**
POLYCHLORINATED BIPHENYLS	
Fluorescent light ballasts were identified throughout the Boiler and Mechanical Rooms.	› **Approximately 18 fluorescent light fixtures** were identified in the Assessed Areas.
OZONE DEPLETING SUBSTANCES	
Two chiller units were identified in the Boiler Room. › One in-service unit. › One labelled as not in service and containing no refrigerant.	 › **120.0 oz. of R410a.** › N/A
MERCURY	
No mercury-containing thermostats or equipment were observed in the Assessed Areas.	› N/A
Fluorescent light tubes were identified in conjunction with fluorescent light ballasts identified throughout the assessed areas.	› Approximately 18 light fixtures were identified containing fluorescent light tubes.
RADIOLOGICAL SOURCES AND SUBSTANCES	
Heat detectors, each with an assumed radiological source, were identified in the Mechanical Room and are assumed to be present in the Boiler Room.	› N/A
SILICA	
› **Concrete floors** were identified in the Boiler and Mechanical Rooms. › **Cinder block and mortar or concrete walls** are assumed to be present beneath the drywall in the Boiler and Mechanical Rooms. › **Drywall and drywall joint compound** were identified on the walls of the Boiler Room.	› N/A
BIOLOGICAL HAZARDS	
› **No suspect biological hazards** (e.g., rodent faeces) were identified in the Assessed Areas.	› N/A
MOULD AND/OR MOISTURE	
› **Evidence of historical moisture presence** (rust coloured staining on the floor) was observed in the Boiler Room. No mould was identified in conjunction with the staining. › **Dripping water** was observed from a pipe associated with the boiler unit nearest the Boiler Room door. No mould was identified in conjunction with the dripping fixture or on the floor beneath.	› N/A

Appendix II

Drawings

- 651548-BM01 – Building Material Survey Sampling Plan – POD 2 Roof
- 651548-BM02 – Building Material Survey Sampling Plan – POD 2 Third Floor



LEGEND

0 1 2 10 METRES

P18 ●	PAINT SAMPLE WITH LEAD CONCENTRATION LESS THAN OR EQUAL TO 90 mg/kg
P21 ●	PAINT SAMPLE WITH LEAD CONCENTRATION GREATER THAN 90 mg/kg AND LESS THAN 600 mg/kg
P17 ●	PAINT SAMPLE WITH LEAD CONCENTRATION GREATER THAN OR EQUAL TO 600 mg/kg
A13 ●	ASBESTOS SAMPLE WITH CONCENTRATION LESS THAN 0.5%
A14 ●	ASBESTOS SAMPLE WITH CONCENTRATION GREATER THAN OR EQUAL TO 0.5%

REFERENCE DRAWINGS

DWG. NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK
0	2018-01-08	ISSUED TO CLIENT	PES	MAH

SNC·LAVALIN

CLIENT NAME: PUBLIC WORKS AND GOVERNMENT SERVICES

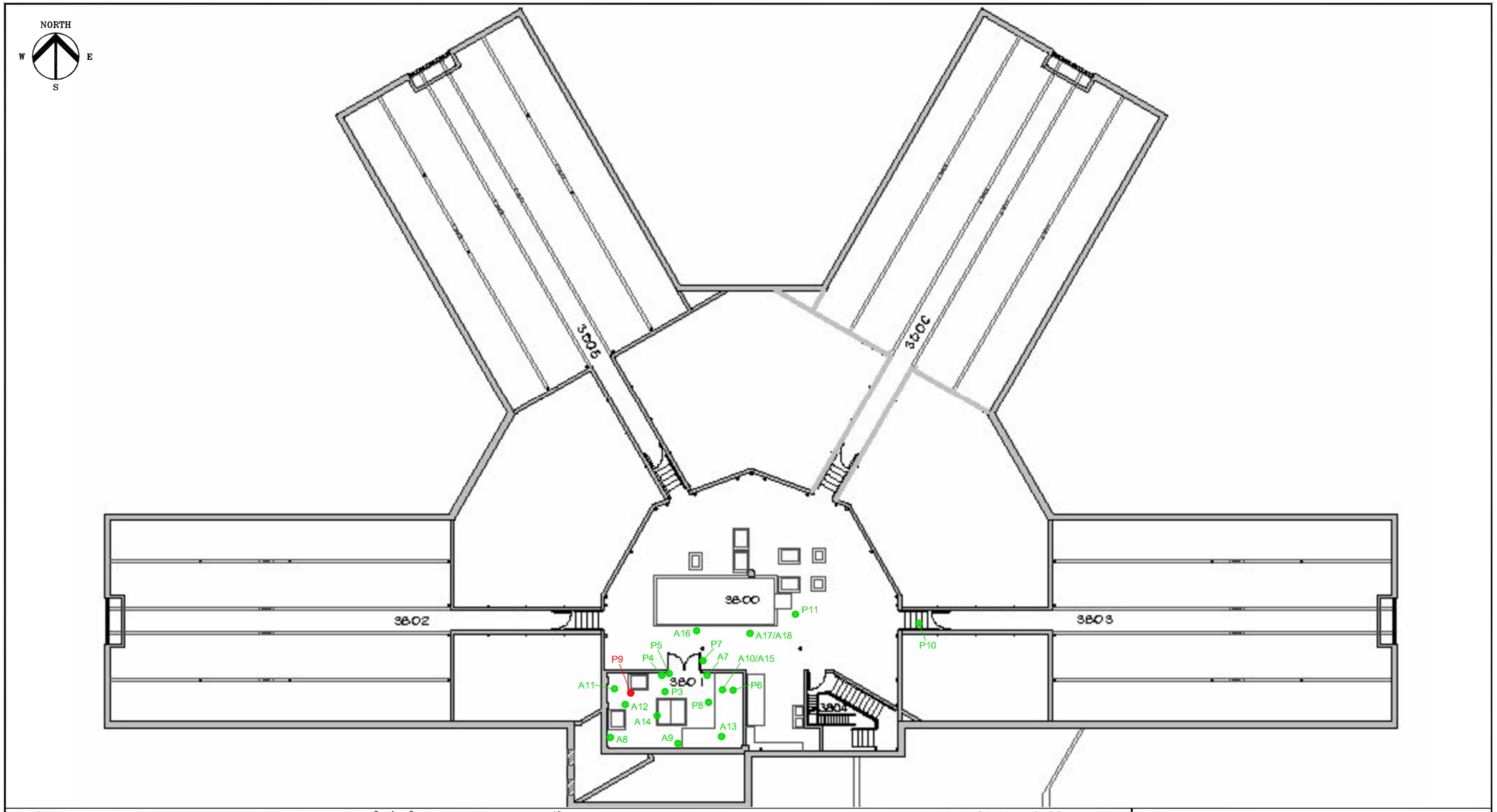
PROJECT LOCATION: KENT INSTITUTION AGASSIZ, BC

TITLE:

BUILDING MATERIAL SURVEY SAMPLING PLAN - POD 2 ROOF

DWN BY: PRT	SCALE: 1:200	DATE: 2018-01-03	DWG No: 651548-BM01 REV.: 0
CHK'D: MAH	PLOT: 20180108.1416	CADFILE: 651548-BM0	

PATH: P:\CURRENT PROJECTS\PWGSC\651548 – POD 2 HBMA – KENT\4.0 EXECUTION\4.5 GIS AND DRAWINGS\CAD\651548-BM0.DWG



LEGEND

0 1 2 10 METRES

- P18 ● PAINT SAMPLE WITH LEAD CONCENTRATION LESS THAN OR EQUAL TO 90 mg/kg
- P21 ● PAINT SAMPLE WITH LEAD CONCENTRATION GREATER THAN 90 mg/kg AND LESS THAN 600 mg/kg
- P17 ● PAINT SAMPLE WITH LEAD CONCENTRATION GREATER THAN OR EQUAL TO 600 mg/kg
- A13 ● ASBESTOS SAMPLE WITH CONCENTRATION LESS THAN 0.5%
- A14 ● ASBESTOS SAMPLE WITH CONCENTRATION GREATER THAN OR EQUAL TO 0.5%

REFERENCE DRAWINGS

DWG. NO.	DATE	DESCRIPTION

REVISIONS

REV.	DATE	DESCRIPTION	BY	CHK
0	2018-01-08	ISSUED TO CLIENT	PES	MAH

SNC·LAVALIN

CLIENT NAME: PUBLIC WORKS AND GOVERNMENT SERVICES

PROJECT LOCATION: KENT INSTITUTION AGASSIZ, BC

TITLE:

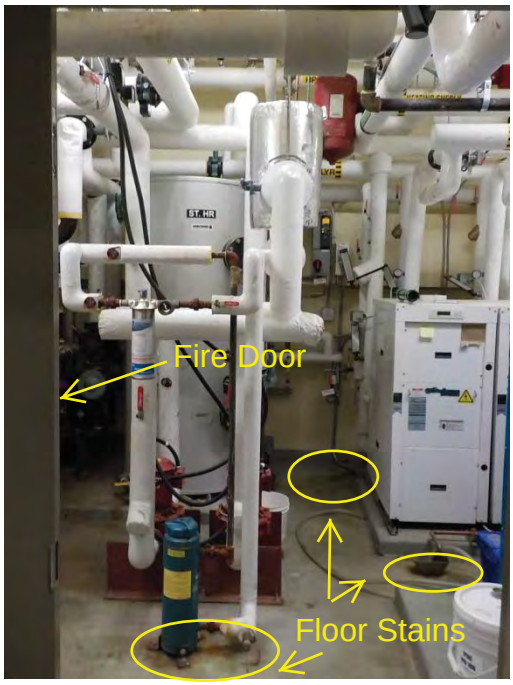
BUILDING MATERIAL SURVEY
SAMPLING PLAN - POD 2 THIRD FLOOR

DWN BY: PRT	SCALE: 1:200	DATE: 2018-01-03	DWG No: 651548-BM02 REV.: 0
CHK'D: MAH	PLOT: 20180108.1339	CADFILE: 651548-BM0	

PATH: P:\CURRENT PROJECTS\PWGSC\651548 – POD 2 HBMA – KENT\4.0 EXECUTION\4.5 GIS AND DRAWINGS\CAD\651548-BM0.DWG

Appendix III

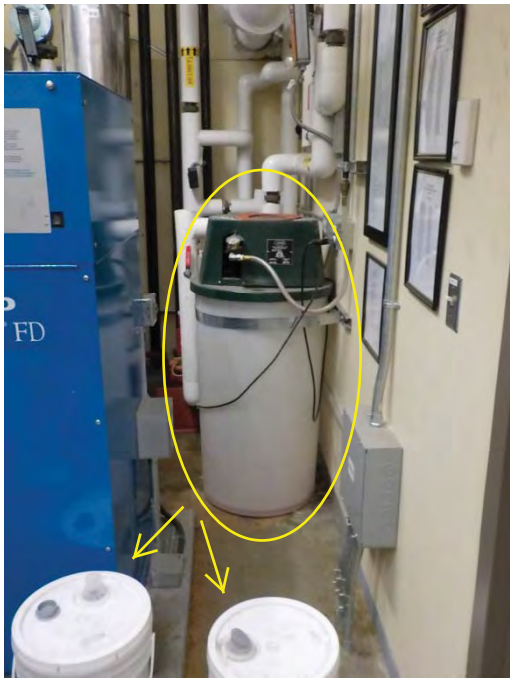
Photographs



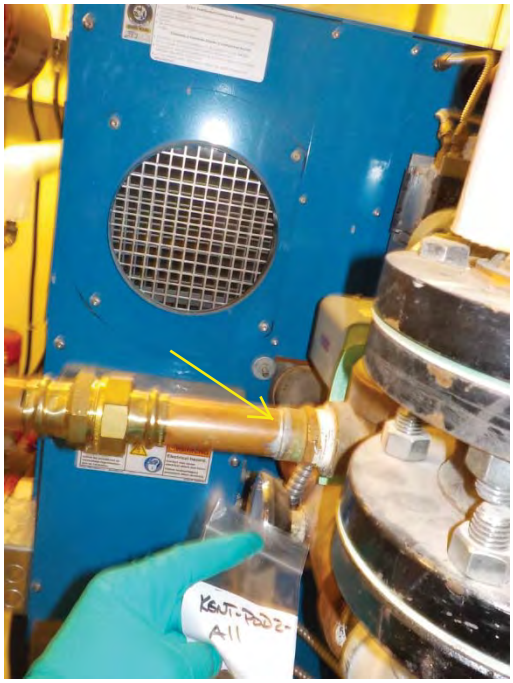
Photograph 1: View from the entrance to the boiler room. The entry doors and frame are fire-rated doors and may contain asbestos-containing filler. Rust coloured stains are visible on the concrete floor.

Photograph 2: Lead-containing teal green paint on a valve assembly associated with one of the two boiler units. Both boiler units have a valve assembly with lead-containing teal green paint.

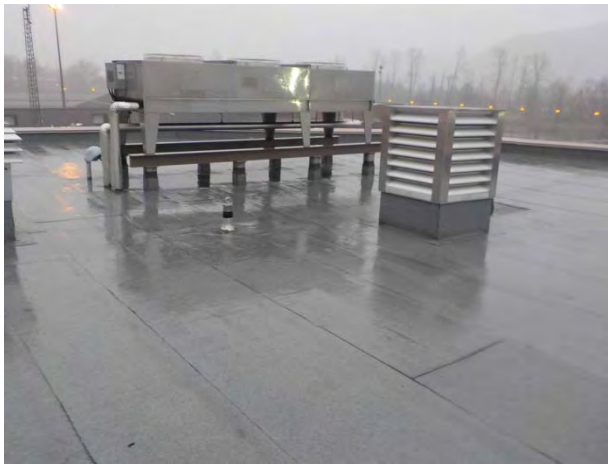
Photograph 3: The two heat exchangers located in the boiler room. The unit on the right is the active unit, containing R410a.



Photograph 4: The white plastic tank with the black top was labeled “Glycol Tank”, and the two pails in the foreground were labeled “Glycol”.



Photograph 5: Copper piping with solder which may contain lead. One of the boilers is visible in the background. The collected sample did not contain asbestos.



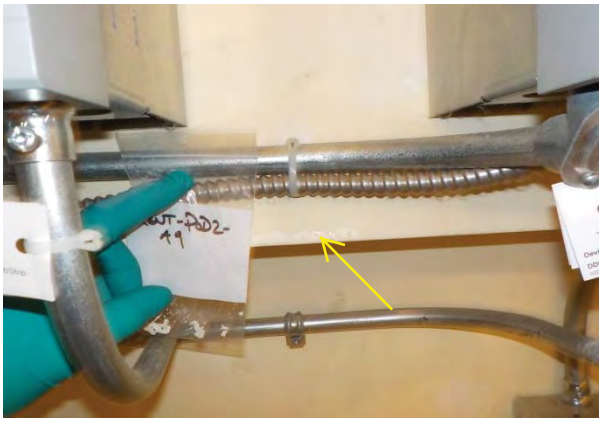
Photograph 6: General roof layout from roof hatch.

Photograph 7: Non-asbestos roof mastic (Samples A4, A5, and A6).

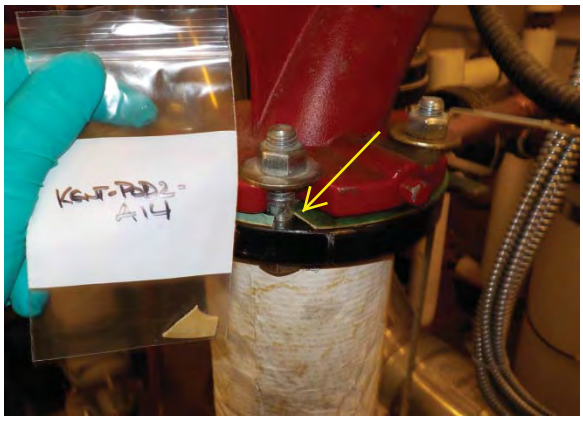
Photograph 8: Hot water storage tank in Boiler Room.

Photograph 9: Boiler number 2 (of 2 boilers) located in the Boiler Room.

Photograph 10: Typical non-mercury temperature gauge on equipment in Boiler Room.



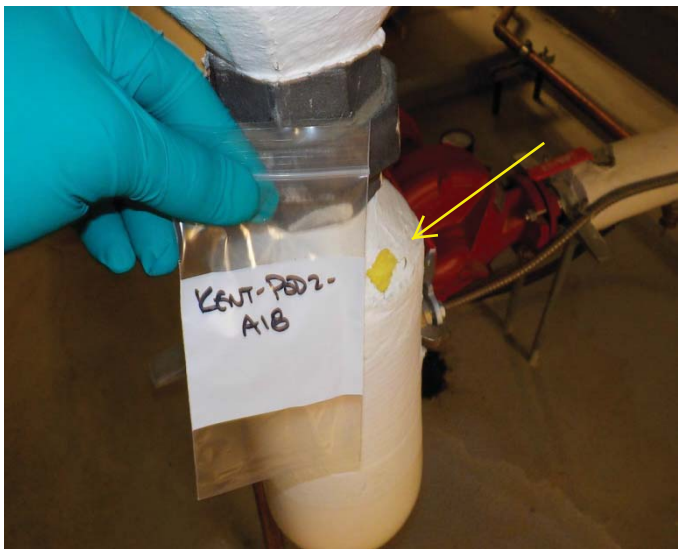
Photograph 11: Non-asbestos drywall joint compound (Samples A7, A8, and A9) in Boiler Room.



Photograph 12: Typical non-asbestos gasket (Sample A14) located on boiler piping in Boiler Room.

Photograph 13: Non-lead containing red paint (Sample P6) on piping of hot water storage tank in Boiler Room.

Photograph 14: Non-lead containing red paint (Sample P8) on pump labelled P1CHW in Boiler Room.



Photograph 15: Non-asbestos insulation plaster (Samples A16, A17, and A18) on piping insulation ends in Mechanical Room.

Appendix IV

Laboratory Analytical Report

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: 651548
Site Location: KENT POD 2
Your C.O.C. #: G125039, G125040, G125041

Attention: Tim Drozda

SNC-LAVALIN INC.
BURNABY, ENVIRONMENT DIVISION
8648 COMMERCE COURT
BURNABY, BC
CANADA V5A 4N6

Report Date: 2017/12/29
Report #: R2497304
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7B2299
Received: 2017/12/19, 17:18

Sample Matrix: Bulk
Samples Received: 18

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Asbestos by PLM - 0.5 RDL (1)	18	N/A	2017/12/28	BBY5SOP-00020	NIOSH 9002 Issue #2

Sample Matrix: PAINT
Samples Received: 11

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by ICP-AES (acid extr. solid)	11	2017/12/22	2017/12/22	BBY7SOP-00018	EPA 6010c R3 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Maxxam Analytics' Asbestos Laboratory is accredited by NVLAP for bulk asbestos analysis by polarized light microscopy, NVLAP Code 600163-0.

This report may not be reproduced, except in full, without the written approval of Maxxam Analytics. This report may not be used by the client to claim product endorsement by NVLAP, NIST or any other agency of the U.S. Government.

Maxxam Analytics' scope of accreditation includes EPA-600/M4-82-020: "Interim Method for the Determination of Asbestos in Bulk Insulation Samples" and EPA-600/R-93/116: "Method for the Determination of Asbestos in Bulk Building Materials".

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Your Project #: 651548
Site Location: KENT POD 2
Your C.O.C. #: G125039, G125040, G125041

Attention: Tim Drozda

SNC-LAVALIN INC.
BURNABY, ENVIRONMENT DIVISION
8648 COMMERCE COURT
BURNABY, BC
CANADA V5A 4N6

Report Date: 2017/12/29
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MAXXAM JOB #: B7B2299
Received: 2017/12/19, 17:18

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) P.O.B. - Percent of Bulk

Encryption Key Graham Rudkin
Graham Rudkin
Project Manager, Environmental
29 Dec 2017 15:27:39

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Dan Woolger, Project Manager
Email: dwoolger@maxxam.ca
Phone# (604) 734 7276

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

BULK ASBESTOS ANALYSIS (BULK)

Maxxam ID		SS2593	SS2594	SS2595	SS2596	SS2597	SS2598	
Sampling Date		2017/12/19 10:15	2017/12/19 10:17	2017/12/19 10:20	2017/12/19 10:25	2017/12/19 10:30	2017/12/19 10:35	
COC Number		G125040	G125040	G125040	G125040	G125040	G125040	
	UNITS	KENT-POD2-A1	KENT-POD2-A2	KENT-POD2-A3	KENT-POD2-A4	KENT-POD2-A5	KENT-POD2-A6	QC Batch
Polarized Light Microscop								
Asbestos PLM	%	ASB RPT	ASB RPT	ASB RPT	ASB RPT	ASB RPT	ASB RPT	8874223

Maxxam ID		SS2598	SS2599	SS2600	SS2601	SS2602	SS2603	
Sampling Date		2017/12/19 10:35	2017/12/19 10:40	2017/12/19 10:45	2017/12/19 10:50	2017/12/19 10:55	2017/12/19 11:00	
COC Number		G125040	G125040	G125040	G125040	G125041	G125041	
	UNITS	KENT-POD2-A6 Lab-Dup	KENT-POD2-A7	KENT-POD2-A8	KENT-POD2-A9	KENT-POD2-A10	KENT-POD2-A11	QC Batch
Polarized Light Microscop								
Asbestos PLM	%	ASB RPT	ASB RPT	ASB RPT	ASB RPT	ASB RPT	ASB RPT	8874223
Lab-Dup = Laboratory Initiated Duplicate								

Maxxam ID		SS2604	SS2605	SS2606	SS2607	SS2608	
Sampling Date		2017/12/19 11:05	2017/12/19 11:10	2017/12/19 11:15	2017/12/19 11:20	2017/12/19 11:25	
COC Number		G125041	G125041	G125041	G125041	G125041	
	UNITS	KENT-POD2-A12	KENT-POD2-A13	KENT-POD2-A14	KENT-POD2-A15	KENT-POD2-A16	QC Batch
Polarized Light Microscop							
Asbestos PLM	%	ASB RPT	ASB RPT	ASB RPT	ASB RPT	ASB RPT	8874223

Maxxam ID		SS2608	SS2609	SS2610	
Sampling Date		2017/12/19 11:25	2017/12/19 11:30	2017/12/19 11:35	
COC Number		G125041	G125041	G125041	
	UNITS	KENT-POD2-A16 Lab-Dup	KENT-POD2-A17	KENT-POD2-A18	QC Batch
Polarized Light Microscop					
Asbestos PLM	%	ASB RPT	ASB RPT	ASB RPT	8874223
Lab-Dup = Laboratory Initiated Duplicate					

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

LEAD IN PAINT CHIPS (PAINT)

Maxxam ID		SS2582		SS2583		SS2584	SS2584		SS2585		
Sampling Date		2017/12/19 10:42		2017/12/19 10:52		2017/12/19 11:02	2017/12/19 11:02		2017/12/19 11:17		
COC Number		G125039		G125039		G125039	G125039		G125039		
	UNITS	KENT-POD2-P1	RDL	KENT-POD2-P2	RDL	KENT-POD2-P3	KENT-POD2-P3 Lab-Dup	RDL	KENT-POD2-P4	RDL	QC Batch
Total Metals by ICP											
Total Lead (Pb)	mg/kg	18.9 (1)	6.0	<9.0 (1)	9.0	<12 (1)	<12 (1)	12	<15 (1)	15	8871152

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
(1) Detection limits raised due to insufficient sample volume.

Maxxam ID		SS2586	SS2587		SS2588		SS2589		SS2590		
Sampling Date		2017/12/19 11:23	2017/12/19 11:28		2017/12/19 11:32		2017/12/19 11:38		2017/12/19 11:52		
COC Number		G125039	G125039		G125039		G125039		G125039		
	UNITS	KENT-POD2-P5	KENT-POD2-P6	RDL	KENT-POD2-P7	RDL	KENT-POD2-P8	RDL	KENT-POD2-P9	RDL	QC Batch
Total Metals by ICP											
Total Lead (Pb)	mg/kg	<15 (1)	36 (1)	15	<12 (1)	12	19 (1)	15	1180 (1)	24	8871152

RDL = Reportable Detection Limit
(1) Detection limits raised due to insufficient sample volume.

Maxxam ID		SS2591		SS2592		
Sampling Date		2017/12/19 11:57		2017/12/19 12:17		
COC Number		G125039		G125040		
	UNITS	KENT-POD2-P10	RDL	KENT-POD2-P11	RDL	QC Batch
Total Metals by ICP						
Total Lead (Pb)	mg/kg	<12 (1)	12	<15 (1)	15	8871152

RDL = Reportable Detection Limit
(1) Detection limits raised due to insufficient sample volume.

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

Asbestos Analytical Results

Asbestos Fiber Identification: analysis was performed based on NIOSH Method 9002 "Asbestos (bulk) by PLM", Polarized Light Microscopy/Dispersion Staining.

KENT-POD2-A1

Maxxam ID: SS2593 Date Analyzed: 2017/12/28

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Beige Rubbery mix	Not Detected		Non-Fibrous

KENT-POD2-A2

Maxxam ID: SS2594 Date Analyzed: 2017/12/28

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Beige Rubbery mix	Not Detected		Non-Fibrous

KENT-POD2-A3

Maxxam ID: SS2595 Date Analyzed: 2017/12/28

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Beige Rubbery mix	Not Detected		Non-Fibrous

KENT-POD2-A4

Maxxam ID: SS2596 Date Analyzed: 2017/12/28

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Black Rubbery mix	Not Detected		Non-Fibrous

The limit of quantitation is 0.50%, although asbestos may be qualitatively detected at concentrations less than 0.50%. Samples for which asbestos is detected at <0.50% are reported as trace, “<0.50%”. “Not Detected” indicates that no asbestos fibres were observed.

Calibrated Visual Estimate (%)
Date Format : yyyy/mm/dd

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

Asbestos Analytical Results

Asbestos Fiber Identification: analysis was performed based on NIOSH Method 9002 "Asbestos (bulk) by PLM", Polarized Light Microscopy/Dispersion Staining.

KENT-POD2-A5

Maxxam ID: SS2597 Date Analyzed: 2017/12/28

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Black Rubbery mix	Not Detected		Non-Fibrous

KENT-POD2-A6

Maxxam ID: SS2598 Date Analyzed: 2017/12/28

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Black Rubbery mix	Not Detected		Non-Fibrous

KENT-POD2-A7

Maxxam ID: SS2599 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous White Joint Compound	Not Detected		Non-Fibrous

KENT-POD2-A8

Maxxam ID: SS2600 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous White Joint Compound	Not Detected		Non-Fibrous

The limit of quantitation is 0.50%, although asbestos may be qualitatively detected at concentrations less than 0.50%. Samples for which asbestos is detected at <0.50% are reported as trace, "<0.50%". "Not Detected" indicates that no asbestos fibres were observed.

Calibrated Visual Estimate (%)
Date Format : yyyy/mm/dd

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

Asbestos Analytical Results

Asbestos Fiber Identification: analysis was performed based on NIOSH Method 9002 "Asbestos (bulk) by PLM", Polarized Light Microscopy/Dispersion Staining.

KENT-POD2-A9

Maxxam ID: SS2601 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous White Joint Compound	Not Detected		Non-Fibrous

KENT-POD2-A10

Maxxam ID: SS2602 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Beige Plaster	Not Detected		Non-Fibrous

KENT-POD2-A11

Maxxam ID: SS2603 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Beige Plaster	Not Detected		Non-Fibrous

KENT-POD2-A12

Maxxam ID: SS2604 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Beige Plaster	Not Detected		Non-Fibrous

The limit of quantitation is 0.50%, although asbestos may be qualitatively detected at concentrations less than 0.50%. Samples for which asbestos is detected at <0.50% are reported as trace, "<0.50%". "Not Detected" indicates that no asbestos fibres were observed.

Calibrated Visual Estimate (%)
Date Format : yyyy/mm/dd

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

Asbestos Analytical Results

Asbestos Fiber Identification: analysis was performed based on NIOSH Method 9002 "Asbestos (bulk) by PLM", Polarized Light Microscopy/Dispersion Staining.

KENT-POD2-A13

Maxxam ID: SS2605 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres		Particulate
Layer 1	100	Homogeneous Brown Fibrous mix	Not Detected	Cellulose	40%	Non-Fibrous
				Glass Fibres	15%	

KENT-POD2-A14

Maxxam ID: SS2606 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres		Particulate
Layer 1	100	Homogeneous Brown Fibrous mix	Not Detected	Cellulose	40%	Non-Fibrous
				Glass Fibres	15%	

KENT-POD2-A15

Maxxam ID: SS2607 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres	Particulate
Layer 1	100	Homogeneous Redish Flooring Material	Not Detected		Non-Fibrous

KENT-POD2-A16

Maxxam ID: SS2608 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres		Particulate
Layer 1	100	Homogeneous White Fibrous mix	Not Detected	Glass Fibres	10%	Non-Fibrous

The limit of quantitation is 0.50%, although asbestos may be qualitatively detected at concentrations less than 0.50%. Samples for which asbestos is detected at <0.50% are reported as trace, "<0.50%". "Not Detected" indicates that no asbestos fibres were observed.

Calibrated Visual Estimate (%)
Date Format : yyyy/mm/dd

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

Asbestos Analytical Results

Asbestos Fiber Identification: analysis was performed based on NIOSH Method 9002 "Asbestos (bulk) by PLM", Polarized Light Microscopy/Dispersion Staining.

KENT-POD2-A17

Maxxam ID: SS2609 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres		Particulate
Layer 1	100	Homogeneous White Fibrous mix	Not Detected	Glass Fibres	10%	Non-Fibrous

KENT-POD2-A18

Maxxam ID: SS2610 Date Analyzed: 2017/12/29

	P.O.B	Sample Morphology	Asbestos	Other Fibres		Particulate
Layer 1	100	Homogeneous White Fibrous mix	Not Detected	Glass Fibres	10%	Non-Fibrous

The limit of quantitation is 0.50%, although asbestos may be qualitatively detected at concentrations less than 0.50%. Samples for which asbestos is detected at <0.50% are reported as trace, "<0.50%". "Not Detected" indicates that no asbestos fibres were observed.

Calibrated Visual Estimate (%)
Date Format : yyyy/mm/dd

Maxxam Job #: B7B2299
Report Date: 2017/12/29

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

GENERAL COMMENTS

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B7B2299
Report Date: 2017/12/29

QUALITY ASSURANCE REPORT

SNC-LAVALIN INC.
Client Project #: 651548
Site Location: KENT POD 2
Sampler Initials: MAH

			Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8871152	Total Lead (Pb)	2017/12/22	<3.0	mg/kg	NC (1)	40	90	80 - 120

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Detection limits raised due to insufficient sample volume.

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CHAIN OF CUSTODY RECORD

G125039
BBY FCD-00077/07
Page 1 of 3

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: SNC-Lavalin Inc.	Company Name: AS AT LEFT	Quotation #: SNC-Lavalin Priority.	☒ Regular TAT 5 days (Most analyses)
Contact Name: Tim Drozda/Aaron Hall	Contact Name:	P.O. #/ AFE#:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 8648 Commerce Court Burnaby, BC PC: V5A 4N6	Address: PC:	Project #: 651548	Rush TAT (Surcharges will be applied) ☐ Same Day ☐ 2 Days ☐ 1 Day ☐ 3 Days
Phone: 604-515-5751	Phone: cc results to	Site Location: KENT POD 2	
Email: tim.drozda@snclavalin.com	Email: aaron.hall@snclavalin.com	Site #:	Date Required:
		Sampled By: MAH	Rush Confirmation #:

Regulatory Criteria

☐ BC CSR Soil ☐ BC CSR Water
☐ YK CSR Soil ☐ YK CSR Water
☐ CCME (Specify) ☐ Other (Specify)
Lead <90ppm Asbestos <0.5%
☐ Drinking Water ☐ BC Water Quality

Special Instructions

☐ Return Cooler
☐ Ship Sample Bottles (Please Specify)

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Analysis Requested

	Sample Identification	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	BTEXS / VPH	BTEX / F1	PAH	EPH	Dissolved Metals	Dissolved Mercury	Total Metals	Total Mercury	Chloride	TSS	pH	Nitrite	Lead in Paint	Asbestos			# OF CONTAINERS SUBMITTED	HOLD - DO NOT ANALYZE
1	KENT-POD2-P1	2017/12/19	1042	Paint													X				1	
2	KENT-POD2-P2	2017/12/19	1052	Paint													X				1	
3	KENT-POD2-P3	2017/12/19	1102	Paint													X				1	
4	KENT-POD2-P4	2017/12/19	1117	Paint													X				1	
5	KENT-POD2-P5	2017/12/19	1123	Paint													X				1	
6	KENT-POD2-P6	2017/12/19	1128	Paint													X				1	
7	KENT-POD2-P7	2017/12/19	1132	Paint													X				1	
8	KENT-POD2-P8	2017/12/19	1138	Paint													X				1	
9	KENT-POD2-P9	2017/12/19	1152	Paint													X				1	
10	KENT-POD2-P10	2017/12/19	1157	Paint													X				1	

LABORATORY USE ONLY

CUSTODY SEAL Y / N		COOLER TEMPERATURES
Present	Intact	
NA	NA	NA

COOLING MEDIA PRESENT Y / N

COMMENTS

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)
			HUDSON ALVARADO	2017/12/19	17:18
M. Aaron Hall	2017/12/19	1715			

B7B2299_COC

COC-1020

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CHAIN OF CUSTODY RECORD

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BBY FCD-00077/07
Page 2 of 3

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: SNC-Lavalin Inc.	Company Name: As At Left	Quotation #: SNC-Lavalin Pricing.	☒ Regular TAT 5 days (Most analyses)
Contact Name: Tim Drozda / Aaron Hall	Contact Name:	P.O. #/ AFE#:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 8648 Commerce Court	Address:	Project #: 651548	Rush TAT (Surcharges will be applied)
Burnaby, BC PC: V5A 4N6	PC:	Site Location: Kent Pod2	☐ Same Day ☐ 2 Days
Phone: 604-515-5151	Phone: cc results to	Site #:	☐ 1 Day ☐ 3 Days
Email: tim.drozda@snclavalin.com	Email: aaron.hall@snclavalin.com	Sampled By: MAH	Date Required:

Regulatory Criteria

☐ BC CSR Soil ☐ BC CSR Water
☐ YK CSR Soil ☐ YK CSR Water
☐ CCME (Specify) ☐ Other (Specify)
Lead <90ppm Asbestos <0.5%
☐ Drinking Water ☐ BC Water Quality

Special Instructions

☐ Return Cooler
☐ Ship Sample Bottles (Please Specify)

Analysis Requested

☐ BTEXS / VPH ☐ VOC / BTEXS / VPH ☐ MTBE; ☐ BTEX / F1 ☐ VOC / BTEX / F1; ☐ PAH ☐ LEPH/HEPH/PAH; ☐ EPH ☐ TEH ☐ F2 - F4; Dissolved Metals ☐ Filtered? ☐ Preserved?; Dissolved Mercury ☐ Filtered? ☐ Preserved?; Total Metals ☐ Field Preserved?; Total Mercury ☐ Field Preserved?; ☐ Chloride ☐ Fluoride ☐ Sulphate; ☐ TSS ☐ TDS ☐ BOD ☐ COD; ☐ pH ☐ Conductivity ☐ Alkalinity; ☐ Nitrite ☐ Nitrate ☐ Ammonia; Lead in Paint; Asbestos; Positive stop of sample above; # OF CONTAINERS SUBMITTED; HOLD - DO NOT ANALYZE

Rush Confirmation #:

LABORATORY USE ONLY

CUSTODY SEAL Y / (N)		COOLER TEMPERATURES
Present	Intact	
NA	NA	NA

COOLING MEDIA PRESENT Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

#	Sample Identification	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	Lead in Paint	Asbestos	Positive stop of sample above	# of Containers Submitted	Hold - Do Not Analyze	Comments
1	KENT-POD2-P11	2017/12/19	1217	Paint	X			1		
2	KENT-POD2-A1	2017/12/19	1015	Mastic		X		1		
3	KENT-POD2-A2	2017/12/19	1017	Mastic			X	1		
4	KENT-POD2-A3	2017/12/19	1020	Mastic			X	1		
5	KENT-POD2-A4	2017/12/19	1025	Mastic		X		1		
6	KENT-POD2-A5	2017/12/19	1030	Mastic			X	1		
7	KENT-POD2-A6	2017/12/19	1035	Mastic			X	1		
8	KENT-POD2-A7	2017/12/19	1040	Drywall compound		X		1		
9	KENT-POD2-A8	2017/12/19	1045	Drywall compound			X	1		
10	KENT-POD2-A9	2017/12/19	1050	Drywall compound			X	1		

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)
M. Aaron Hall	2017/12/19	1715	Alvotan Auwanou	2017/12/19	17:18

COC-1020

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CHAIN OF CUSTODY RECORD

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Page 3 of 3

Invoice Information	Report Information (if differs from invoice)	Project Information (where applicable)	Turnaround Time (TAT) Required
Company Name: SNC-Lavalin Inc.	Company Name: As At Left	Quotation #: SNC-Lavalin Pricing	☒ Regular TAT 5 days (Most analyses)
Contact Name: Tim Drozda / Aaronhall	Contact Name:	P.O. #/ AFE#:	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 8648 Commerce Court	Address:	Project #: 651548	Rush TAT (Surcharges will be applied)
Burnaby BC PC: V5A 4N6	PC:	Site Location: KENT POD 2	☐ Same Day ☐ 2 Days
Phone: 604-515-5151	Phone: cc results to	Site #:	☐ 1 Day ☐ 3 Days
Email: tim.drozda@snclavalin.com	Email: aaron.hall@snclavalin.com	Sampled By: MAH	Date Required:

Regulatory Criteria	Special Instructions	Analysis Requested	Rush Confirmation #:
☐ BC CSR Soil ☐ BC CSR Water	☐ Return Cooler	VOC / BTEXS / VPH ☐ MTBE ☐; BTEXS / VPH ☐; VOC / BTEX / F1 ☐; BTEX / F1 ☐; LEPH/HEPH/PAH ☐; PAH ☐; F2 - F4 ☐; TEH ☐; EPH ☐; Dissolved Metals: Filtered? ☐ Preserved? ☐; Dissolved Mercury: Filtered? ☐ Preserved? ☐; Total Metals: Field Preserved? ☐; Total Mercury: Field Preserved? ☐; Chloride ☐ Fluoride ☐ Sulphate ☐; TSS ☐ TDS ☐ BOD ☐ COD ☐; pH ☐ Conductivity ☐ Alkalinity ☐; Nitrite ☐ Nitrate ☐ Ammonia ☐; Lead in Paint; Asbestos; Positive Stop If Sample Above	LABORATORY USE ONLY
☐ YK CSR Soil ☐ YK CSR Water	☐ Ship Sample Bottles (Please Specify)		CUSTODY SEAL Y / (N): Present NA, Intact NA; COOLER TEMPERATURES NA
☐ CCME (Specify) ☐ Other (Specify)			COOLING MEDIA PRESENT Y / N
Lead <90ppm Asbestos <0.5%			
☐ Drinking Water ☐ BC Water Quality			

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

#	Sample Identification	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	Notes	Lead in Paint	Asbestos	Positive Stop If Sample Above	# OF CONTAINERS SUBMITTED	HOLD - DO NOT ANALYZE	COMMENTS
1	KENT-POD2-A10	2017/12/19	1055	Mastic			X		1		
2	KENT-POD2-A11	2017/12/19	1100	Mastic			X		1		
3	KENT-POD2-A12	2017/12/19	1105	Mastic		X	X		1		
4	KENT-POD2-A13	2017/12/19	1110	Gasket			X		1		
5	KENT-POD2-A14	2017/12/19	1115	Gasket				X	1		
6	KENT-POD2-A15	2017/12/19	1120	Gasket			X		1		
7	KENT-POD2-A16	2017/12/19	1125	TSI	White layer only		X		1		
8	KENT-POD2-A17	2017/12/19	1130	TSI	White layer only		X		1		
9	KENT-POD2-A18	2017/12/19	1135	TSI	White layer only		X		1		
10											

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)
			Audean Aucamp	2017/12/19	17:18
M Aaron Hall	2017/12/19	1715			

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