Public Works and
Government Services Canada

Requisition No. EZ899-180194

DRAWINGS & SPECIFICATIONS
for

Matsqui Institution
Living Units M3
AHU Replacements

R.082466.001

APPROVED BY:

Regional Manager, AES — Date

Construction Safety Coordinator — Date 2017.02.15

Project Manager — Date 2017.05.03

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CONSULTANTS – SEAL & SIGNATURE

Discipline	**Seal / Signature / Date**
Mechanical (Prime)	MAY 1 2017 PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA J.H. KG 25038
Electrical	PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA P. J. NECPAL # 38720 May 1, 2017

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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 Matsqui Institution in Abbotsford, BC.

.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 phasing. 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 01 11 00 Summary of Work.

.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 20 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. 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 Administrative:

.1 Submit to Departmental Representative submittal 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 are not produced in SI Metric units, converted values are acceptable.

.5 Review submittal 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. Submittal 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 review of submittal.

.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.

.2 Shop Drawings:

.1 Drawings to be originals prepared by Contractor, Subcontractor, Supplier or Distributor, which illustrate appropriate portion of work; showing fabrication, layout, setting or erection details as specified in appropriate sections.

.3 Product Data:

.1 Certain specification Sections specify that manufacturer's standard schematic drawings, catalogue sheets, diagrams, schedules, performance charts, illustrations and other standard descriptive data will be accepted in lieu of shop drawings, provided that the product concerned is clearly identified. Submit in sets, not as individual submissions.

.4 Samples:

.1 Submit samples in sizes and quantities specified.

.2 Where colour is criterion, submit full range of colours.

.3 Submit all samples as soon as possible after the contract is awarded, to facilitate production of complete colour scheme by the Departmental Representative.

.5 Mock-ups:

.1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of all Sections required to provide mock-ups.

.2 Construct in location as specified in specific Section.

.3 Prepare mock-ups for Departmental Representative review with reasonable promptness and in an orderly sequence, so as not to cause any delay in Work.

.4 Failure to prepare mock-ups 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.

.5 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when.

.6 Progress Photographs:

.1 Provide construction photographs in accordance with procedures and submission requirements specified in this clause.

.2 Progress Photographs:

.1 Provide digital photographs with images of minimum 3.1 mega pixel resolution and stored in Jpeg format with minimal compression.

.2 Number of viewpoints: four (4), locations of viewpoints directed by Departmental Representative.

.3 Frequency: monthly, submitted on disk with monthly progress statement, sent via e-mail or as directed by Departmental Representative.

.4 Identify photos by location, date and sequential numbering system.

.3 Final Photographs:

.1 Provide digital photographs with images of minimum 3.1 mega pixel resolution and stored in Jpeg format with minimal compression. Where photos are e-mailed compression can be increased.

.2 Number of viewpoints:

.1 Each side of building for a total of 4.

.2 Interior of rooms and finishes for a total of 8.

.3 Locations of viewpoints determined by Departmental Representative.

.3 Submit final photographs in digital format on CD, before final acceptance of building.

.4 Label disks and identify with name and project number of project. Indicate exposure dates and viewpoints of each photo and photo number.

.7 Submission Requirements:

.1 Schedule submissions at least ten days before dates reviewed submissions will be needed.

.2 Submit number of copies of product data, shop drawings which Contractor requires for distribution plus four (4) copies which will be retained by Departmental Representative.

.3 Accompany submissions with transmittal letter in duplicate.

.4 Submit bond copies (hard copy) as directed by Departmental Representative.

.8 Coordination of Submissions:

.1 Review shop drawings, product data and samples prior to submission.

.2 Coordinate with field construction criteria.

.3 Verify catalogue numbers and similar data.

.4 Coordinate each submittal with requirements of the work of all trades and contract documents.

.5 Responsibility for errors and omissions in submittal is not relieved by Departmental Representative's review of submittal.

.6 Responsibility for deviations in submittal from requirements of Contract documents is not relieved by Departmental Representative's review of submittal, unless Departmental Representative gives written acceptance of specified deviations.

.7 Notify Departmental Representative, in writing at time of submission, of deviations in submittal from requirements of Contract documents.

.8 Make any changes in submissions which Departmental Representative may require consistent with Contract Documents and re-submit as directed by Departmental Representative.

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

.10 Shop Drawings Review:

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

.2 The Departmental Representative's review does not mean that PWGSC approves the detail design inherent in the shop drawings, responsibility remains with the contractor submitting same, and such review will not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the construction and contract documents.

.3 Without restricting the generality of the foregoing, the Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for co-ordination of the work of all subtrades.

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 (NBCC2010) and where applicable British Columbia Building Code (BCBC2012) 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 Inspection:

.1 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.

.2 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.

.3 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.

.2 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.

.3 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.

.4 Reports:

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

.5 Tests and Mix Designs:

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

.6 Mock-ups:

.1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of all Sections required to provide mock-ups.

.2 Construct in locations acceptable to Departmental Representative and as specified in specific Section.

.3 Prepare mock-ups for Departmental Representative review with reasonable promptness and in an orderly sequence, so as not to cause any delay in Work.

.4 Failure to prepare mock-ups 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.

.5 If requested, Departmental Representative will assist in preparing a schedule fixing dates for preparation.

.6 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when.

.8 Equipment and Systems:

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

.2 Refer to specific Section for definitive requirements.

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 Reference Standards:

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

.2 Cost for such testing will be born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance.

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

.2 Quality:

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

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

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

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

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

.3 Storage, Handling and Protection:

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

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

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

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

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

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

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

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

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

.4 Transportation:

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

.2 Transportation cost of products supplied by Departmental Representative will be paid for by Departmental Representative. Unload, handle and store such products.

.5 Manufacturer's Instructions:

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

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

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

.6 Quality of Work:

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

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

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

.7 Co-ordination:

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

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

8 Concealment:

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

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

.9 Remedial Work:

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

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

.10 Location of Fixtures:

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

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

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

.11 Fastenings:

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

.2 Prevent electrolytic action between dissimilar metals and materials.

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

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

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

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

.12 Fastenings - Equipment:

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

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

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

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

.13 Protection of Work in Progress:

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

.14 Existing Utilities:

.1 Where work involves breaking into or connecting to existing services, carry out work at times directed by governing authorities, with minimum of disturbance to pedestrian and vehicular traffic.

.2 Before commencing work, establish location and extent of service lines in areas of work and notify Departmental Representative of findings.

.3 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility. Adhere to approved schedule and provide notice to affected parties.

.4 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.

.5 Record locations of maintained, capped and re-routed services lines.

.15 Contractors Options for Selection of Products:

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

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

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

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

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

.16 Substitution after award of Contract:

.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.

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

.1 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, unless approved by Departmental Representative.

.3 Clear snow and ice from access to building.

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

.5 Provide and use clearly marked separate bins for recycling. Refer to- Construction/Demolition Waste Management And Disposal.

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

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

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

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

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

.2 Final Cleaning:

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

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

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

.4 Remove waste products and 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.

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

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

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

.8 Wax, seal, vacuum clean, shampoo or prepare floor finishes, as recommended by manufacturer.

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

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

.11 Remove dirt and other disfiguration from exterior surfaces.

.12 Sweep and wash clean paved areas.

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

.14 Clean roofs, downspouts, and drainage systems.

.15 Remove snow and ice from access to building.

1.16 CONSTRUCTION/DEMOLITION WASTE MANAGEMENT AND DISPOSAL

.1 Provide on-site facilities for collection, handling, and storage of anticipated quantities of reusable and/or recyclable materials and waste.

.1 Separate non-salvageable materials from salvaged items.

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

.3 Transport and deliver non-salvageable items to licensed disposal facility.

.2 Provide containers to deposit reusable and/or recyclable materials. Locate containers in locations, to facilitate deposit of materials without hindering daily operations. Provide containers to deposit reusable and/or recyclable materials.

.3 Collect, handle, store on-site and transport off-site, salvaged materials in separate condition. Transport to approved and authorized recycling facility and/or users of material for recycling.

.4 Locate waste and salvage bins on site as directed by Departmental Representative.

1.17 CLOSEOUT PROCEDURES

.1 Inspection and Declaration:

.1 Contractor's Inspection: Conduct an inspection of Work with all subcontractors, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.2 Notify Departmental Representative in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.

.3 Request Departmental Representative's Inspection.

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

.3 Substantial Completion: submit written certificate that following have been performed:

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

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

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

.4 Fire alarm verification report per CAN/ULC-S537, confirmation of proper installation of fire alarm panel to CAN/ULC-S527 signed off by the fire alarm technician and confirmation of fire alarm emergency power capacity. 24-hour battery test as described in CAN/ULC-S537, signed off by fire alarm technician.

.5 Confirmation of emergency power lighting, operating on emergency power for the required amount of time as dictated by NBCC, signed off by technician.

.6 Certificates required by Authority Having Jurisdictions for fire protection systems.

.7 Certificates required by Authority Having Jurisdictions for seismic restraints.

.8 Operation of systems have been demonstrated to Departments personnel.

.9 Work is complete and ready for Final Inspection.

.10 Draft O&M manuals have been submitted.

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

1.18 CLOSEOUT SUBMITTAL

.1 Record Drawings:

.1 As work progresses, maintain accurate records to show all deviations from the Contract Drawings. Note on as-built drawings as changes occur. At completion supply:

.1 Four (4) sets of CD's in AutoCad file format (version: 2014) with all as-built information on the diskettes.

.2 Four (4) sets of as-built plotted reproducible drawings.

.3 Four (4) sets of printed as-built drawings.

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

.5 Departmental Representative will supply copies of the original AutoCad files.

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

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

.2 Maintenance manual:

.1 On completion of project submit to Departmental Representative four (4) CD R/ disk copies and four (4) paper copies (in loose leaf type binder) of Operations and Maintenance Manual, made up as follows:

.1 Provide maintenance manual on CDs using pdf, or other approved format for descriptive writing, page size images and page size drawings. Organize manuals into industry standard maintenance manual tabs with links in index to each descriptive section describing the component or maintenance procedure etc.

.2 Organize files into CSI Masterformat numbering system or other approved descriptive titles.

.3 Label disk "Operation and Maintenance Data", project name, date, names of Contractor, subcontractors, consultants and subconsultants.

.4 Include scanned guarantees, diagrams and drawings.

.5 Organize contents into applicable sections of work to parallel project specification break-down. Mark each section by labeled tabs (navigational buttons)..

.6 Drawings, diagrams and manufacturer's literature must be legible.

.7 Refer to Mechanical and Electrical Divisions for specific details for Mechanical and Electrical data.

.3 Maintenance Materials, Special Tools and Spare Parts:

.1 Specific requirements for maintenance materials, tools and spare parts are specified in individual sections.

.2 Deliver maintenance materials, special tools and spare parts to Departmental Representative and store in designated area as directed by Departmental Representative.

.3 Prepare lists of maintenance materials, special tools and spare parts for inclusion in Manual specified in Clause 18.2.

.4 Maintenance materials:

.1 Deliver wrapped, identify on carton or package, colour, room number, system or area as applicable where item is used.

.5 Special tools:

.1 Assemble as specified;

.2 Include identifications and instructions on intended use of tools.

.6 Spare parts:

.1 Assemble parts as specified;

.2 Include part number, identification of equipment or system for which parts are applicable;

.3 Installation instructions;

.4 Name and address of nearest supplier.

.4 Warranties and Bonds:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing in maintenance manual.

.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 Interim Completion is determined.

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

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

1.19 GENERAL COMMISSIONING

.1 Commissioning (See Section 01 91 13).

.2 Commission installed systems prior to Demonstration and Training.

1.20 DEMONSTRATION AND TRAINING

.1 Demonstration and Training (See Section 01 91 41):

.1 Demonstrate operation and maintenance of equipment and systems to maintenance personnel following interim Completion and prior to date of final certificate of completion

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

END OF SECTION

Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract includes:

.1 Removal of the four existing HVAC air handling unit (AHU) systems currently serving the Living Units North, South, West, East Wings, and replacement with new AHU systems. The new AHUs shall be shipped "knocked down" and/or in modular components to allow transport into their final positions.

.2 Removal of existing variable frequency drives (VFDs), and disconnects, serving the exhaust systems and air handling units, and replacement with new VFDs complete with disconnects.

.3 Removal of existing HVAC control devices and replacement and upgrade with new components and modification to the sequence of operation programming.

.4 Installation of new ductwork and piping systems related to the new AHU systems.

.5 Removal and reinstallation of duct smoke detectors in accordance with CAN/ULC s524.

.6 Re-verification of fire alarm system related to the AHU systems in accordance with CAN/ULC s537.

.7 Provide complete commissioning of new AHU systems, VFDs, and controls.

At the Matsqui Institution (Building M3) in Abbotsford, BC and further identified as the "Work".

1.2 WORK SEQUENCE

.1 Construction period shall be determined in coordination with the Departmental Representative.

.2 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 CPIC form and scanned copy of government issued ID for each employee to the Departmental Representative.

.2 Allow 10 working days for processing of security clearances. Employees will not be admitted to the Institution without a valid security clearance in place and a recent picture identification such as a provincial driver's license. Security clearances obtained from other CSC institutions are not valid at this institution except as approved otherwise.

.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 waved 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 contractors 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

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 00 01 50 General Instructions (CSC)

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 00 01 50.

.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 00 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 00 01 50.

.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 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 Requirements

.1 Section 01 91 41 Demonstration and Training

.2 Section 23 05 00 Common Work Results for HVAC

.3 Section 23 08 00 Mechanical Commissioning

.4 Section 26 05 00 Common Work Results for Electrical

.3 Acronyms:

.1 Cx - Commissioning

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

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

.4 BMS – Building Management 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.

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

.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, and relevant

commissioning activities are delegated to the mechanical commissioning agent.

.3 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 Agents, Commissioning Manager, sub-contractors, equipment suppliers, O&M personnel, Facility Manager, 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 Departmental Representative'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 as described herein.

1.5 COMMISSIONING OVERVIEW

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

.2 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues 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.

.3 Commissioning is not complete until:

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

.2 Testing & Balancing is complete.

.3 Equipment, components and systems have been commissioned.

.4 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 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 At the early start of Construction:

.1 Review contract documents for

.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 for review.

.7 Have Cx schedules up-to-date.

.8 Ensure systems have been cleaned thoroughly.

.9 Complete TAB procedures on systems, submit TAB reports for review.

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

.4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.8 CONFLICTS

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

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

1.9 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 00 01 50 – General Instructions (CSC).

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

.1 Name of Contractor's Cx Agent.

.2 Draft Cx documentation (Cx Plan, Cx checksheets, Cx Forms, etc.)

.3 Preliminary Cx schedule.

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

.3 Submit proposed Cx procedures 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.

1.10 COMMISSIONING DOCUMENTATION

.1 Contractor's Cx Agent shall submit their proposed Cx plan, checksheets, forms for review prior to implementation.

.2 Provide completed and reviewed Cx documentation with the Cx Summary Report.

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 4 Cx meetings: Kickoff, 75% progress, 90% progress and final.

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

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

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

.6 Ensure subcontractors and relevant manufacturer representatives are present at kickoff 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 2 weeks notice prior to commencement to allow adequate presence of relevant witnesses.

.2 Notify Departmental Representative of start-up dates, Departmental Representative 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.

.3 Arrange for tests to be witnessed by Departmental Representative.

.4 Obtain written review of test results and documentation from Departmental Representative before delivery to site.

.2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and submit for review.

.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 performance verifications 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 performance verification: include repetition of tests after correcting deficiencies.

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

.3 Correct deficiencies before commencing to next phase.

.4 Document the required tests on performance verification forms.

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency. 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 Departmental Representative.

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

.3 If evaluation report concludes that major damage has occurred, Departmental Representative 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 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 performance verification produce unacceptable results, repair, replace or repeat specified starting and/or performance verification procedures until acceptable results are achieved.

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

1.20 START OF COMMISSIONING

.1 Notify Departmental Representative at least 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 for review:

.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 and/or scissor lift.

.3 Other miscellaneous equipment as required to complete Cx work (smoke pencil, airflow measuring tools, etc.)

1.22 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:

.1 Under actual and/or simulated operating conditions, over entire operating range, in all operational 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 Direct Digital Controls (DDC) trending to be available as supporting documentation for performance verification.

1.23 WITNESSING COMMISSIONING

.1 Allow Departmental Representative to witness and/or spot check activities and verify results (provide 2 weeks notification).

1.24 AUTHORITIES HAVING JURISDICTION

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

.2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.

.3 Provide copies within 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 and possibly due to weather, it is necessary to complete Cx of 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 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 Exact number and location to be at discretion of the Departmental Representative.

.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.

1.28 REPEAT VERIFICATIONS

.1 Assume costs incurred by commissioning activities for third and subsequent verifications where:

.1 Verification of reported results that fail to receive the Departmental Representative's recommended approval.

.2 Repetition of second verification again fails to receive the Departmental Representative's recommended approval.

.3 The 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 commissioning.

.2 Report problems, faults or defects affecting commissioning. Pause commissioning work until problems are rectified, then continue with commissioning once issues are resolved.

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 Departmental Representative.

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 – Demonstration and 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 during stages of acceptance and occupancy of facility.

1.36 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and performance

verification if:

.1 Accuracy complies with these specifications.

.2 Calibration certificates have been submitted.

.2 Calibrated DDC 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 +/- 5% of recorded values.

1.38 PERFORMANCE TESTING

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

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 91 13 – Commissioning

.2 Section 23 05 00 – Common Work Results for HVAC

.3 Section 23 08 00 – Mechanical Commissioning

.4 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's 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 QUALITY CONTROL

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

1.4 SUBMITTALS

.1 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Departmental Representative's approval.

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

.3 Give time and date of each demonstration, with list of persons present.

1.5 CONDITIONS FOR DEMONSTRATIONS

.1 Equipment has been inspected and put into operation.

.2 Testing, adjusting, and balancing has been performed in accordance with Section 23 05 93 and equipment and systems are fully operational at all operational modes.

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

1.6 PREPARATION

.1 Verify that conditions for demonstration and instructions comply with requirements. Prepare supplemental literature and handouts.

.2 Verify that designated personnel are present.

1.7 DEMONSTRATION AND INSTRUCTIONS

.1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the 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.

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 00 01 50 – General Instructions (CSC)

.2 Section 02 81 01 – Hazardous Materials

.3 Section 02 82 00.01 – Asbestos Abatement Minimum Precautions

.4 Section 02 82 00.02 – Asbestos Abatement Intermediate Precautions

.5 Section 02 82 00.03 – Asbestos Abatement Maximum Precautions

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 00 01 50 – 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 Mission Medium 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.

.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 (1) 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 00 01 50 – General Instructions

.2 Section 01 35 33 - Health and Safety Requirements

1.2 REFERENCES

.1 Assessment Reports: See 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.

.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 (Jus)

.1 Transportation of Dangerous Goods Act, 1992 (TDG Act), (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 2015.

.5 WorkSafe BC

.1 British Columbia's Occupational Health and Safety Regulation (BC Reg. 296/97, including amendments to date of work)

.2 "Lead-Containing Paints and Coatings; Preventing Exposure in the Construction Industry", 2011

.6 British Columbia Hazardous Waste Regulation (BC Reg. 63/88)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 00 01 50 – General Instructions.

.1 Submit manufacturer's instructions, printed product literature and data sheets for hazardous materials and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies of WHMIS MSDS in accordance with Sections 01 35 33 - Health and Safety Requirements to Departmental Representative for each hazardous material required prior to bringing hazardous material on site.

.3 Submit environmental exposure control plan to Departmental Representative that identifies hazardous materials, usage, location, personal protective equipment requirements, and disposal arrangements.

.4 Submit Provincial and/or local requirements for Notice of Project Form.

.5 Submit proof satisfactory to Departmental Representative that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of authority having jurisdiction.

.6 Submit proof that all asbestos workers and/or supervisor have received appropriate training and education by a competent person in the hazards of asbestos exposure, good personal hygiene and work practices while working in Asbestos Work Areas, and the use, cleaning and disposal of respirators and protective clothing.

.7 Construction Waste Management:

.1 Submit project Demolition Waste Management Plan highlighting recycling and salvage requirements.

.2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating percentage of construction wastes were recycled or salvaged

.8 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 materials in accordance 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 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 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 Ensure personnel have been trained in accordance with Workplace Hazardous Materials Information System (WHMIS) requirements.

.11 Report spills or accidents immediately to Departmental Representative. Submit a written spill report to Departmental Representative within 24 hours of incident.

.5 Develop Demolition Waste Management Plan related to Work of this Section.

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 for the project.

.1 Abatement shall be conducted to remove and dispose of hazardous building materials as identified in the Assessment Report(s) in accordance with applicable regulations, guidelines, standards and/or best practices for such work, where such identified hazardous building materials will be impacted (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 hazardous building material categories and associated removal and disposal regulations, guidelines and/or standards.

.1 Removal, alteration and/or disposal of ACMs is not anticipated to be required during the Work.

.1 Notify Departmental Representative of suspected ACM discovered during Work and not apparent from drawings, specifications, or report pertaining to Work. Do not disturb such material pending instructions from DCC Representative.

.2 Lead and Lead-Containing Paints (LCPs)

.1 The following LCPs may require disturbance during the Work.

.1 Tan concrete floor paint in mechanical room.

.2 Green/Grey paint on AHU.

.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 WorkSafe BC publication "Lead-Containing Paint and Coatings: Preventing Exposure in the Construction Industry", 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 (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.

.4 As part of the work, Contractor is to clean-up LCP debris created by their activities as well as any LCP debris that may be present (pre-existing) on the ground or surrounding area of the work area.

.5 Waste transportation to be conducted in accordance with BC Reg. 63/88 and the Federal Transportation of Dangerous Goods Regulation.

.6 Waste disposal to be conducted in accordance with BC Reg. 63/88.

.3 Polychlorinated Biphenyls (PCBs)

.1 The following PCBs may require disturbance during the Work.

.1 Fluorescent lights.

.2 When decommissioned, verify the PCB content of fluorescent lamp ballasts as per the Environment Canada publication Identification of Lamp Ballasts Containing PCBs, 1991.

.3 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.

.4 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 The following Mercury may require disturbance during the Work.

.1 Fluorescent lights.

.2 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.

.3 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/m³ 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 Removal, alteration and/or disposal of refrigeration or air conditioning equipment with ODS refrigerants is not anticipated to be required during the Work.

.7 Silica

.1 The following silica-containing materials may be disturbed during the Work.

.1 Concrete

.2 Concrete block

.3 Brick

.4 Mortar

.2 When silica-containing materials are to be disturbed and/or removed (e.g., coring through concrete slabs, demolition of masonry or concrete units), ensure dust control measures are employed such that airborne silica dust concentrations do not exceed the exposure limit as stipulated by BC Reg. 296/97 (Cristobalite and Quartz – each 0.025 mg/m³). This would include, but not be limited to, the following:

.1 Providing workers with respiratory protection

.2 Wetting the surface of the materials, use of water or dust suppressing agents to prevent dust emissions

.3 Providing workers with facilities to properly wash prior to exiting the work area.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 00 01 50 – General Instructions. 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 00 01 50 – General Instructions.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 00 01 50 – General Instructions.

.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 SUBMITTALS

.1 Submittals: in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF electronic format. The PDF electronic format will be used for insertion into the Operating and Maintenance and/or Commissioning Manuals.

.3 Shop drawings to show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances.

.4 Shop drawings and product data accompanied by:

- .1 Detailed drawings of bases, supports, and anchor bolts.
- .2 Acoustical sound power data, where applicable.
- .3 Points of operation on performance curves.
- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.

.5 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in the Closeout Submittals requirements in Section 00 01 50 – General Instructions (CSC).
- .2 Operation and maintenance manual approved by, and final copies deposited with Departmental Representative before final inspection.
- .3 Operation data to include:
  - .1 Control schematics for systems including environmental controls.
  - .2 Description of systems and their controls.
  - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
  - .4 Operation instruction for systems and component.
  - .5 Description of actions to be taken in event of equipment failure.
  - .6 Valves schedule and flow diagram.
  - .7 Colour coding chart.
- .4 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required and task time.

.5 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing.

.6 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manuals to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Draft O&M Manuals submission is required prior to substantial completion.

.3 Make changes as required and re-submit as directed by Departmental Representative.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Departmental Representative will provide 1 set of mechanical drawings for mark up. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information daily and/or weekly to drawings, revising drawings to show work as actually installed.

.3 Use different colour ink for each service.

.4 Make available for reference purposes and inspection.

.9 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

.3 Submit to Departmental Representative for approval and make corrections as directed.

.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.

.5 Submit completed marked up as-built drawings with Operating and Maintenance Manuals.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 MAINTENANCE

.1 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.2 Provide one set of special tools as required to service equipment as recommended by manufacturers.

1.1 DELIVERY, STORAGE AND HANDLING

.1 Protect on site per paragraph 1.12.3 of section 00 01 50 General Instructions (CSC).

1.2 WASTE MANAGEMENT AND DISPOSAL:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with paragraph 1.16 of section 00 01 50 General Instructions (CSC).

Part 2 Products

2.1 DUCT AND PIPE MOUNTED CONTROL AND SENSING EQUIPMENT

.1 The following automatic control equipment will be supplied by the Division 23 (mechanical) but installed by the appropriate trade sections of the Division 23 Mechanical Contract:

.1 Automatic control valves.

.2 Temperature control wells.

.3 Pressure tappings.

.4 Flow switches.

.5 Automatic control dampers.

.6 Static pressure sensors.

Part 3 Execution

3.1 EXISTING UNDERGROUND SERVICES

.1 Protect all existing underground services encountered. Obtain instructions from Departmental Representative when existing services require relocation or modifications, other than those already indicated in the Contract Documents.

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

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

.4 In order to maintain existing services in operation, provide temporary relocations and/or bypasses of piping.

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

3.2 CUTTING, PATCHING, DIGGING, CANNING AND CORING

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

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

.3 Be responsible for correct location and sizing of all openings required under Division 23, including pipe sleeves and duct openings. Allow oversized openings for fire dampers and pipe penetrations where insulation is specified.

.4 Verify the location of existing service runs and steel reinforcing within existing 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 All openings shall be core drilled or diamond saw cut.

3.3 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-M85 and ASTM E814 standards 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.

3.4 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.

3.5 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 0.61mm 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 0.61mm 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 and protruding 150 mm beyond sleeve diameter. Annular fin shall be embedded into centre of wall.

.5 Pipe sleeves for wet or washdown floor areas shall be Schedule 40 steel pipe, unless indicated otherwise.

.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 above floors in unfinished areas and wet areas and 6 mm above floors in finished areas, unless indicated otherwise.

.8 Pipe sleeves shall extend 25 mm on each side of walls in unfinished areas and 6 mm in finished areas.

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

.10 Sleeve Size: 12 mm 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.

3.6 ESCUTCHEONS AND SLEEVES

.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.

3.7 EQUIPMENT SUPPORTS

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

.2 Lay out concrete bases and curbs required under Division 23 and structural drawings.

.3 Concrete bases shall be a minimum of 100 mm thick, or as noted and shall project at least 150 mm 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 mm 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.

.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.

3.8 EQUIPMENT RESTRAINT

.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 Refer to Section 23 05 49 - Seismic Restraint.

3.9 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. Avoid creating tripping hazards.

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

3.10 ANCHOR BOLTS AND TEMPLATES

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

3.11 MISCELLANEOUS METALS

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

.1 Support of equipment

.2 Hanging, support, anchoring, guiding and relative work as it applies to piping, ductwork, heat exchangers, hot water storage tanks, expansion tanks, fans and mechanical equipment.

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

.4 Pipe anchor and/or support posts.

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

.2 All steel work shall be primed and undercoat painted.

3.12 FLASHING

.1 Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floors, and roofs.

.2 Flash, vent and soil pipes projecting 75 mm minimum above finished roof

surface with lead worked 25 mm minimum into hub, 200 mm minimum clear on side with minimum 600 x 600 mm sheet size. For pipes through outside walls turn flange back into wall and caulk.

.3 Provide curbs for mechanical roof installations 200 mm minimum high above roof insulation. Flash and counterflash with galvanized steel, soldered and made waterproofed.

.4 Provide continuous lead or neoprene safes for built-up mop sinks, and shower stalls located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm into walls or to top of curbs and caulk into joints.

3.13 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.

3.14 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.

3.15 PAINTING

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

.2 Repaint all marred factory finished equipment supplied under Division 23, which is not scheduled to be repainted, to match the original factory finish.

.3 Natural gas and fire protection piping shall be painted for identification purposes over their entire lengths throughout all exposed areas and in the mechanical room(s) as follows:

.1	Gas:	Yellow	C.G.S.B.	505-101
.2	Fire:	Red	C.G.S.B.	509-102

.4 Painting of all equipment and materials, supplied under Division 23, installed in mechanical equipment areas and inside finished areas of the building or exposed outside the building, is included in the mechanical scope.

3.16 EQUIPMENT PROTECTION AND CLEAN UP

.1 Protect equipment and material in storage, on site and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 All mechanical equipment stored on site shall be kept in a dry, heated and ventilated storage area.

.3 Thoroughly clean piping, ducts and equipment of dirt, cuttings, and other foreign material.

.4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.5 Provide, install and maintain 30% efficient temporary filters to return and exhaust air openings from ceiling spaces to prevent air born dust from entering ducts, plenums and coils. Install filters to return air grilles when fans are operated and building is not at a clean condition.

3.17 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 00 01 50 – General Instructions, Quality Control subsection, and submit report.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work.

3.18 SYSTEMS DEMONSTRATIONS

.1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

.4 Departmental Representative may record these demonstrations on video for future reference.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Bases, pads, hangers and supports for mechanical piping, ducting and equipment.

1.2 RELATED SECTIONS

.1 Section 23 05 49 - Seismic Restraint

.2 Section 23 07 15 - Thermal Insulation for Piping

1.3 REFERENCES

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

.1 ANSI/ASME B31.1-2007, Power Piping.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM A125-1996 (R2007), Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-10, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-07a, Specification for Carbon and Alloy Steel Nuts.

.3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

.4 Thermal Insulation Association of Canada (TIAC)

1.4 SYSTEM DESCRIPTION

.1 Design Requirements:

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by MSS SP58 and ASME B31.1.

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

.2 Performance Requirements:

.1 Design supports, platforms, catwalks, hangers, to withstand seismic events as specified Section 23 05 49 - Seismic Restraint.

1.5 SUBMITTALS

.1 Submittals: in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF. The PDF will be used for insertion into the Operating and Maintenance and/or Commissioning Manuals.

.3 Shop drawings: submit drawings stamped and signed by Professional Engineer registered or licensed in Province of British Columbia, Canada.

.4 Submit shop drawings and product data for following items:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.5 Quality Control Check Sheets

.6 Closeout Submittals: Provide all applicable close-out submittals per section 00 01 50 – General Instructions (CSC).

1.6 QUALITY CONTROL

.1 General:

.1 Contractor to be responsible for quality control of the products and installation in this section.

.2 Quality Control Program Submittals:

.1 Quality Control Check Sheet

.2 Check sheets to include the following information:

.1 Pipe or ductwork system

.2 Equipment number, make and model, including weights

.3 Pipe support type and spacing

.4 Pipe support finish (corrosion protection, painted)

.5 Details of pipe attachment to structure

.6 Hanger details at pipe insulation (where applicable and specified)

.7 Comments on seismic installation

.3 For each tabulated item, state the following:

.1 Does the item comply with the specification? Yes/No/Not Applicable.

.2 Identify any areas of non compliance and the proposed action to make it compliant.

Part 2 Products

2.1 GENERAL

.1 Provide hangers and supports to secure equipment in place, prevent vibration, protect appropriate against damage from earthquake, maintain grade, provide for expansion and contraction and accommodate insulation.

.2 Provide insulation protection saddles on all insulated piping.

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

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

.5 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.

.6 Do not suspend from metal deck.

2.2 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.3 WALL SUPPORTS

.1 Horizontal and Vertical pipe adjacent to wall.

.1 Exposed pipe wall support for lateral movement restraint.

.2 Galvanized or other non corrosive finish.

.3 Channel type support - Burndy, Canadian Strut, Cantruss or Unistrut, type support.

.4 Angle iron wall brackets (galvanized or other non corrosive finish)

with specified hangers.

2.4 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.

2.5 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel.

.2 Calculations shall be signed and sealed by Professional Engineer certified in BC.

2.6 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.7 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel

.2 Submit structural calculations with shop drawings, signed and sealed by Professional Engineer certified in British Columbia.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, and as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

.2 Bolt-tightening torques to industry standards.

.3 Steel pipes: install below coupling or shear lugs welded to pipe.

.4 Cast iron pipes: install below joint.

.4 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.6 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25 % of total load.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Vibration isolation materials and components, seismic control measures and their installation.

1.2 RELATED SECTIONS

.1 Section 23 05 49 - Seismic Restraints

.2 Section 23 33 00 - Air Duct Accessories

1.3 REFERENCES

.1 National Building Code of Canada (NBC) - 2010

1.4 SUBMITTALS

.1 Submittals: In accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF electronic format.

.3 Submit shop drawings in accordance with Division 01Submittal Procedures.

.1 Drawings stamped and signed by Professional Engineer registered or licensed in Province of British Columbia, Canada. Provide Letters of Assurance (Schedule-C).

.2 Provide separate shop drawings for each isolated system complete with performance and product data.

.3 Provide detailed drawings of seismic control measures for equipment and piping.

.4 Manufacturer's Reports

.5 Closeout Submittals: Provide all applicable close-out submittals per paragraph 1.18 "Closeout Submittals" of section 00 01 50 – General Instructions (CSC).

Part 2 Products

2.1 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.

.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.

.6 Provide concrete inertia bases or structural steel bases, where specified or required by equipment manufacturers, located between vibrating equipment and the vibration isolation elements, unless the equipment manufacturer certifies direct attachment capabilities.

.7 Coordinate for the provision of housekeeping pads at least 100 mm high under all isolated equipment, or greater thickness where specified. Provide at least 300 mm 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 consultant's instructions for drilled inserts re: installation of anchors.

.11 Coordinate with Section 23 33 00 - Air Duct Accessories for all ductwork connections to fans or plenums.

.12 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.

.13 Coordinate with Electrical Division 26 for the provision of a minimum 180^0 hanging loop of flexible conduit for all electrical connections to isolated equipment.

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

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

.4 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.

2.3 ISOLATORS – TYPE 1, PADS

.1 Neoprene or neoprene / steel / neoprene pad isolators. Select Type 1 pads for a minimum 2.5 mm static deflection or greater. Use hold down bolts selected for seismic loads. Isolate bolts from base of unit using neoprene hemi-grommets. Avoid over-compressing grommets. Size bolt and hemi-grommet for minimum lateral clearance. Use grommets only on light-weight equipment.

2.4 ISOLATORS – TYPE 2, RUBBER FLOOR MOUNTS

.1 Rubber/neoprene-in-shear isolators designed to meet specified seismic requirements. Select isolators for a 4 mm 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.

2.5 ISOLATORS – TYPE 3, SPRING FLOOR MOUNTS

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

.2 Outdoor or moist installations: Zinc or cadmium plated springs and hardware; housings coated with rust resistant paint.

.3 Colour code springs.

2.6 ISOLATORS – TYPE 4, HANGER MOUNTS

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

.2 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.

.3 Outdoor or moist installations: Zinc or cadmium plated springs and hardware; housings coated with rust resistant paint.

2.7 CLOSED CELL FOAM GASKETS/NEOPRENE GROMMETS – TYPE 7

.1 20 mm 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 20 kPa loading under weight of equipment and allow for 25% compression 5mm. 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 1.3 mm.

Contractor to check fire rating requirements specified for project.

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.

2.9 FLEXIBLE CONNECTORS – TYPE 9

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

2.10 STEEL BASES

.1 Construct structural steel bases sufficiently rigid to keep deflection and misalignment within acceptable limits as determined by the equipment manufacturer.

.2 Use height saving brackets in all mounting locations to provide a base clearance of 35 mm.

.3 Bases to be furnished with built-in motor slide rails. Motor location as specified/scheduled.

.4 Steel bases supplied as integral part of equipment to be supplied meeting the above requirements.

2.11 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

Part 3 Execution

3.1 INSTALLATION

.1 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 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 Type 3 mounts, which do not meet the seismic requirement, provide Type 6 seismic snubbers.

.7 Select Type 4 spring hangers for a minimum static deflection of 25 mm for all ceiling hung fans, and air handling units, emergency generator exhaust piping and silencers, steam PRV's and any other vibrating sources.

.8 Isolate axial fans rotating at more than 1170 RPM on type 2 isolators.

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

.10 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. This requirement includes piping from chiller and emergency generator exhaust.

.11 Provide Type 8 resilient elements in pipe anchors, where pipe anchors are within 12 m of a vibrating source or if located in pipe chases.

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

.13 Be responsible for ensuring that flexible duct connections are installed with a minimum of 40 mm metal-to-metal gap. Use flanges to ensure that flexible connectors are clear of the airstream.

.14 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.

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

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

.17 Slab on grade mounted equipment: For equipment mounted on a slab on grade, mount on type 2 isolators unless otherwise specified.

3.2 INSPECTIONS

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

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

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.

.2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:

.1 After delivery and storage of Products.

.2 After preparatory work is complete but before installation commences.

.3 Once during the installation, at 50% completion stage.

.4 Upon completion of installation.

.3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.

.4 Make adjustments and corrections in accordance with written report.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Seismic restraint systems (SRS) for statically supported and vibration isolated equipment and systems; including mechanical and process equipment, mechanical and process distribution systems, fire protection, both vibration isolated and statically supported, air handling units and exhaust fans roof curb systems.

1.2 REFERENCES

.1 SMACNA – Seismic Restraint Manual – Guidelines for Mechanical Systems.

.2 Canadian Standards Association (CSA International)

.1 CSA G40.20/G40.21-04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.3 National Building Code of Canada (NBC) – 2010

1.3 DEFINITIONS

.1 Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.

.2 SRS: acronym for Seismic Restraint System.

1.4 SCOPE OF WORK

.1 Provide restraint on all piping, ductwork, equipment and machinery, which is part of the building mechanical and process 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.

.6 Designed by Professional Engineer specializing in design of SRS and registered in Province of British Columbia. Provide Letters of Assurance (Schedules B, C-B).

1.5 SUBMITTALS

.1 Submittals: in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF. The PDF will be used for insertion into the Operating and Maintenance and/or Commissioning Manuals.

.3 Shop drawings: submit drawings stamped and signed by Professional Engineer registered or licensed in Province of British Columbia, Canada.

.1 Note that the shop drawings must be specific to this project, with reference and drawings showing attachment to the existing or new structure.

.2 Seismic Engineer to visit site to survey the existing conditions, before submitting the shop drawings.

.3 Generic shop drawings that do not reflect the actual site conditions, will be rejected.

.4 Submit design data including:

.1 Full details of design criteria.

.2 Working drawings (prepared to same standard of quality and size as documents forming these tender documents), materials lists, schematics, full specifications for components of each SRS to be provided.

.3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).

.4 Separate shop drawings for each SRS and devices for each system, equipment.

.5 Identification of location of devices.

.6 Schedules of types of SRS equipment and devices.

.7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.

.8 Installation procedures and instructions.

.9 Design calculations including restraint loads to NBC and Supplement.

.10 Detailed work sheets, tables.

.11 Detailed design of SRS including complete working drawings prepared to same standard of quality and size as Contract Documents, materials lists, design calculations, schematics, specifications.

.5 Quality assurance submittals: Submit the following in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

.6 Certificate of Compliance from Contractor's Seismic Engineer (refer to Clause 3.5.1).

.7 Closeout Submittals: Provide all applicable close-out submittals per section 00 01 50 – General Instructions (CSC).

Part 2 Products

2.1 SRS MANUFACTURER

.1 SRS from one manufacturer, regularly engaged in SRS production.

2.2 GENERAL

.1 SRS to provide gentle and steady cushioning action and avoid high impact loads.

.2 SRS to restrain seismic forces in every direction.

.3 Fasteners and attachment points to resist same load as seismic restraints.

.4 SRS of Piping systems compatible with:

.1 Expansion, anchoring and guiding requirements.

.2 Equipment vibration isolation and equipment SRS.

.5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.

.6 Attachments to reinforced concrete structure:

.1 Use high strength mechanical expansion anchors.

.2 Drilled or power driven anchors not permitted.

.7 Seismic control measures not to interfere with integrity of firestopping.

2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS

.1 Floor-mounted equipment, systems:

.1 Anchor equipment to equipment supports.

.2 Anchor equipment supports to structure.

.3 Use size of bolts scheduled in approved shop drawings.

.2 Suspended equipment, systems:

.1 Use one or combination of following methods:

.1 Install tight to structure.

.2 Cross-brace in every direction.

.3 Brace back to structure.

.4 Slack cable restraint system.

.2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.

.3 Hanger rods to withstand compressive loading and buckling.

2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT

.1 Floor mounted equipment, systems:

.1 Use one or combination of following methods:

.1 Vibration isolators with built-in snubbers.

.2 Vibration isolators and separate snubbers.

.3 Built-up snubber system approved by Departmental Representative, consisting of structural elements and elastomeric layer.

.2 SRS to resist complete isolator unloading.

.3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.

.4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.

.2 Suspended equipment, systems:

.1 Use one or combination of following methods:

.1 Slack cable restraint system.

.2 Brace back to structure via vibration isolators and snubbers.

2.5 SLACK CABLE RESTRAINT SYSTEM (SCS)

.1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.

.2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.

.3 Hanger rods to withstand compressive loading and buckling.

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 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

.3 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 Not used.

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 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), and tie back to the ceiling slab at an angle not exceeding 45 degrees to the slab.

.4 On piping systems, provide transverse slack cable restraints at a maximum spacing of 10 m and longitudinal restraints at 20 m maximum spacing, or as limited by anchor/slack cable performance. For pipes greater than NPS10, reduce transverse restraint spacings to 6.0 m.

.5 Small pipes may be rigidly tied to big pipes for restraint, but not the reverse.

.6 Transverse bracing for one pipe section may also act as longitudinal bracing for the pipe connected perpendicular to it, provided the bracing is installed within 600 mm of the elbow or T, and if the connected pipe is the same or smaller in size. Do not use branch lines to restrain main lines.

.7 Provide flexibility in piping joints or sleeves where pipes pass through building seismic or expansion joints.

.8 At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the centre of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed the transverse spacings discussed above for horizontal pipes, with guide clearance not exceeding 3 mm.

.9 Vary adjacent spacing of restraints on a piping run by 10% to 30% to avoid coincident resonances.

.10 Install restraints at least 50 mm clear of all other equipment and services.

.11 Adjust restraint cables such that they are not visibly slack, or such that the flexibility is approximately 40 mm under thumb pressure for a 1.5 m cable length (equivalent ratio for other cable lengths). Adjust the clearance at cable strap/spacer piece restraints to not exceed 6 mm.

.12 Provide transverse and axial restraints as close as practical to a vertical bend.

.13 At steel trusses, connect to top chords and follow truss manufacturer's instructions.

.14 The maximum spacing between transverse and longitudinal restraints for piping and ductwork shall be 25% less than specified in SMACNA for SHL A.

3.5 FIELD QUALITY CONTROL

.1 Inspection and Certification:

.1 SRS: inspected and certified by Contractor's Seismic Engineer (who signed shop drawings) upon completion of installation.

.2 Provide written report to Departmental Representative with certificate of compliance.

.2 Commissioning Documentation:

.1 Upon completion and acceptance of certification, hand over to Departmental Representative complete set of construction documents, revised to show "as-built" conditions.

3.6 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

1.2 RELATED SECTIONS

.1 Not used.

1.3 REFERENCES

.1 Not used.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 00 01 50 General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF. The PDF will be used for insertion into the Operating and Maintenance and/or Commissioning Manuals.

.3 Shop drawings to indicate the following:

.1 Legend of proposed identification details for each system.

.2 Details of proposed nameplates, labels and tags.

.4 Samples:

.1 Provide a sample of a typical nameplate, label and tag for review and approval of Departmental Representative.

.2 Provide a mock up of each type of piping identification.

.5 Quality Control Check Sheets.

.6 Closeout Submittals:

.1 Submit maintenance data for incorporation into manual.

1.5 QUALITY CONTROL

.1 General:

.1 Contractor to be responsible for quality control of the products and installation in this section.

.2 Submit all information and material required for the Quality Management System, in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.3 Quality Control Program Submittals:

.1 Quality Control Check Sheet

.4 Quality Control Check Sheet:

.1 Prepare and maintain Quality Control Check Sheets.

.2 Check sheet to be kept on site and be made available for review by the Departmental Representative at any time.

.3 Check sheets to be filled in and submitted for review, prior to substantial completion.

.4 Tabulated check list including the following:
- .1 Equipment number and type
- .2 System type
- .3 Equipment and system location
- .4 Identification completed
- .5 Spacing as specified
- .6 Visible from all areas
- .7 Match existing identification
- .8 Corrosion resistant nameplates, tags and ties
- .9 Valve schedule and identification chart

.5 For each tabulated item, state the following:
- .1 Does the item comply with the specification? Yes/No/Not Applicable.
- .2 Identify any areas of non compliance and the proposed action to make it compliant.

Part 2 Products

2.1 GENERAL

.1 There are areas in this project where the relative humidity levels will be high.

.2 Select an identification system that is appropriate for such an environment.

2.2 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Lamacoid nameplate, mechanically fastened to each piece of equipment by manufacturer.

.2 Include ULC, (Underwriters' Laboratories Canada) or CSA, (Canadian Standards Association) registration logos and those of other agencies, as required by the respective agencies.

.3 Nameplates shall be located so that they are easily read. Do not insulate or paint over nameplates.

.4 Lettering and numbers raised or recessed.

.5 Information to include, as appropriate:
- .1 Equipment: manufacturer's name, model, size, serial number, capacity.
- .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.3 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick laminated plastic (lamacoid), matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

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

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5.

.2 Equipment in Mechanical Rooms: use size # 9.

.5 Identify all systems and areas or zones of building being serviced.

2.4 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1.

.1 Paint all natural gas piping yellow.

.2 Sprinklers: to NFPA 13.

.1 Paint all sprinkler piping red.

.3 Standpipe and hose systems: to NFPA 14.

.1 Paint standpipe and hose system piping red.

2.5 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as

necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Departmental Representative.

.2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

2.6 DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: black, or co-ordinated with base colour to ensure strong contrast.

2.7 VALVES, DAMPERS, CONTROLLERS

.1 White lamacoid tags with 12 mm engraved identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.8 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.9 LANGUAGE

.1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TIMING

.1 Provide identification only after painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas, in mechanical rooms, equipment rooms, crawlspace: at not more than 15 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas, service spaces and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with UV rated plastic tie wraps.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively. The numbering format shall match the established building standards.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Testing, Adjusting and Balancing (TAB) is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC systems in the facility.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 SUBMITTALS

.1 Submittals: in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF. The PDF will be used for insertion into the Operating and Maintenance and/or Commissioning Manuals.

.3 Qualifications of TAB Company and Personnel.

.4 Submit, prior to commencement of TAB:

.1 Proposed methodology and procedures for performing TAB if different from referenced standard.

.5 Test Reports: submit certified test reports from approved TAB Company indicating compliance with specifications for specified performance characteristics and physical properties. Include as follows:

.1 Pre-TAB review – confirmation of the adequacy of provisions of TAB (Clause 1.8.1).

.2 List of any standards or procedures that differ from specified standards (Clause 1.8.2).

.3 Preliminary TAB Report (Clause 1.14).

.4 Statutory declaration certifying that the TAB procedures have been completed (Clause 1.19.14).

.5 Fire Damper Test Report (Clause 1.22.3)

.6 Final TAB Report (Clause 1.15)

.6 Quality Control Check Sheet, itemizing all reports and certificates.

1.3 QUALIFICATIONS OF TAB COMPANY AND PERSONNEL

.1 Submit names of personnel to perform TAB to the Departmental Representative within 30 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.

.2 National Environmental Balancing Bureau (NEBB), Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-2006.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing Procedural Guide, 2003.

.4 Use TAB Standard provisions, including checklists, and report forms; submit final report at the completion of the project. Include report in the maintenance manual.

.5 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.6 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.7 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges (simulate filter loading, outdoor air provision, etc).

.4 Note that there is some overlap in responsibility between this section and Section 23 08 00 - Commissioning - Mechanical Systems.

1.5 EXCEPTIONS

.1 Not used.

1.6 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.7 PRE-TAB REVIEW

.1 Review contract documents before project construction is started and confirm in writing to the Departmental Representative the adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to the Departmental Representative in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.9 START OF TAB

.1 Notify Departmental Representative one (1) week prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.1 Pressure, leakage, other tests specified elsewhere in Division 23.

.2 Provisions for TAB installed and operational.

.3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Isolating and balancing valves installed, open.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus or minus 5%.

.2 Hydronic systems: plus or minus 10%.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative a list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.14 TAB REPORT

.1 Format in accordance with SMACNA Guidelines.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 4 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index and index tabs.

.4 Include final TAB report in operating & maintenance manual.

1.15 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.16 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, and ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.17 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

.2 Update and revise the final TAB report per review comments and insert into the operating & maintenance manual.

1.18 TAB GENERAL

.1 Standard: TAB to most stringent of this section or TAB standards of SMACNA or ASHRAE.

.2 Do TAB of following systems, equipment, components, controls:

.1 Outdoor air system(s).

.2 Supply air system(s).

.3 Exhaust air system(s).

.4 Hydronic heating coil(s).

.3 The TAB 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.

.4 Procedures shall be in general accordance with AABC's National Standards for Field Measurement and Instrumentation and ASHRAE Standards.

.5 The TAB agency shall agree to perform spot checks, where requested, in the presence of the Departmental Representative.

.6 Work with the TAB 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 and change sheaves and belts as directed by the agency. Allow for the cost of the replacement sheaves and belts.

.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.

.7 Consult with the Departmental Representative to clarify the design intent where necessary or in case there are any problems foreseen as the balancing processes.

.8 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.

.9 This TAB agency shall remove and re-install ceiling tile to provide access to ductwork and piping. The TAB agency will make good any damage or soiling caused by his forces.

.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 TAB 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. Reports to be signed by the senior member of the TAB agency.

.15 Employ the testing and balancing agency to test all fire dampers as follows:

.1 Test all fire dampers. The test shall be made by releasing the fusible link and witnessing closure of the damper. All fire dampers shall be left in the open position.

.2 A set of prints shall be marked up to show that each damper has checked for closure, accessibility and installation or provide schematic mechanical drawing showing all fire damper locations, label all fire dampers on drawing and reference made in the completed test certificate submitted to the Departmental Representative.

.16 The Balancing Agency shall include for 5 (five) days of return visits for readjustment of systems after the building is occupied and used.

1.19 AIR SYSTEMS TAB

.1 Quality assurance: perform TAB under direction of supervisor qualified to standards of Associated Air Balance Council (AABC), National Standards for Total System Balance or National Environmental Balancing Bureau (NEBB) "Procedural Standards for Testing, Adjusting and Balancing Environmental Systems".

.2 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.3 Systems Data – the following information shall be provided:

.1 Air Handling Equipment:

.1 Design Data:
- .1 Total air flow rate;
- .2 Fan total static pressure;
- .3 System static pressure;
- .4 Motor kW, r/min, amps, volts, phase;
- .5 Outside air flow rate L/s;
- .6 Fan r/min;
- .7 Fan kW;
- .8 Inlet and outlet, dry and wet bulb temperatures.

.2 Installation Date:
- .1 Manufacturer and model;
- .2 Size;
- .3 Arrangement discharge class;
- .4 Motor type, kW, r/min, voltage, phase, cycles, and load amperage;
- .5 Location and local identification data.

.3 Recorded Data:
- .1 Air flow rate;
- .2 Fan total static pressure;
- .3 System static pressure;
- .4 Fan r/min;
- .5 Motor operating amperage;
- .6 Inlet and outlet, dry and wet bulb temperatures.

.2 Duct Air Quantities: All mains supplying more than 10% of Volume, outside air and exhaust (maximum and minimum), major return air openings back to duct shafts or air handling units.
- .1 Duct sizes;
- .2 Number of pressure readings;
- .3 Sum of velocity measurements;
- .4 Average velocity;
- .5 Dust recorded air flow rate;
- .6 Duct design air flow rate.

.3 Air Inlet and Outlets:
- .1 Outlet identification location and designation;
- .2 Manufacturers catalogue identification and type;
- .3 Application factors;
- .4 Design and recorded velocities;
- .5 Design and recorded air flow rates;
- .6 Deflector vane or diffuser cone settings.

.4 Air Heating and Cooling Equipment

.1 Design Data:
- .1 Heat transfer rate;
- .2 Liquid and air flow rates;
- .3 Liquid pressure drop;
- .4 Air static pressure drop;
- .5 Entering and leaving liquid temperatures;
- .6 Entering and leaving air dry and wet bulb temperatures;
- .7 Fluid and air side pressure drops.

.2 Installation Data:
- .1 Manufacturers, model, type;
- .2 Entering and leaving fluid flow and temperatures
- .3 Fluid and air side pressure drops

.3 Recorded Data:
- .1 Element type and identification (location and designation);
- .2 Entering and leaving air dry and wet bulb temperatures;
- .3 Entering and leaving water temperatures;
- .4 Water pressure drop;
- .5 Air static pressure drop;
- .6 Air and water flow rates;
- .7 Adjusted temperature rise or drop.

.4 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

.5 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.

.6 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.

.7 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.

.8 Measure air quantities at each air terminal.

.9 Maintain the design relationship between the supply and exhaust air system quantities.

.10 Check to ensure that supply and return air quantities provide reasonable building pressurization. Document abnormal building leakage conditions noted.

.11 Adjust the air terminals to obtain the optimum air distribution pattern.

.12 Controllers on heating coils 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.

.13 Air systems shall be balanced with clean filters in place, at a total of 105% to 110% of specified total airflow rates.

.14 Where variable air volume systems are installed, take measurements at maximum and minimum flows. Record the minimum operating duct static pressure set-point for each air handling system.

.15 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 at a simulated minimum system condition.

.16 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.

.17 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 Fan and motor speed.

.10 Motor size, starting time, amps and voltage.

.11 Burner air entering and leaving temperatures (D.B. and W.B.).

.12 Maximum and minimum zone supply air temperatures under prevailing conditions at time of test.

.13 Provide fan performance curve for each new air handling system.

1.20 OTHER SYSTEMS

.1 Not used.

1.21 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

.1 Quality assurance: as for systems specified in this section.

.2 Building pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

1.22 POST-OCCUPANCY TAB

.1 Participate in systems checks twice during Warranty Period – at approximately 1 month and 6 months after acceptance. Coordinate exact timing with Commissioning Agent.

.2 Include for two days on site for checking and system balance modifications during each visit.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

1 MECHANICAL FORMS

1.1 MF 100 Check List – Submissions to Departmental Representative

ITEM	CHECKED BY	DATE
PRIOR TO CLOSING IN CEILINGS & SHAFTS - Duct and pipe test data - Piping Test Data (MF 141)		
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 Substantial Performance Division 23 (MF 190) – Certificate of Total Completion (MF 192) – Checklist of Work Remaining (MF 191) – Checklists of Demonstrations (MF 181, 182)		

1.2 MF 141 Piping Test Data

SYSTEM: _____ (Heating water piping)			
Date:		**Time:**	**AM/PM:**
Section of System Tested:			
Pressure at start of Test: _____ kPa [psi] Pressure at end of Test: _____ kPa [psi]		**TEST:** Length: _____ hrs Medium: water /air / nitrogen	
Test Performed by:			
Name:	Signature:	Company:	
Test witnessed at start:			
Name:	Signature:	Company:	
Test witnessed at end:			
Name:	Signature:	Company:	
Remedial Work / Comments:			

1.3 MF 151 Check List - 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 R.A. & Exhaust 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.

1.4 MF 152 Check List - Start-up and Operation Requirements - Water / Glycol 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 Chiller Manufacturers Rep. Present		
Prior to Operation Boiler inspectors Approval Obtained Report from Chemical Treatment Agency Submitted		
During Operation Qualified Operator In Charge Equipment Maintained Lubrication Maintained & Logged Chemical Treatment Maintained And Logged		

NOTES:

.1 This is a brief 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.

1.5 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 23 have been satisfactorily completed and I hereby certify that complete factual reports have been distributed.

SIGNED _____ DATE _____

NOTES:

.1 This certificate must be submitted prior to 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 prior to substantial performance.

1.7 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 23 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 prior to substantial performance.

1.8 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 23 has been satisfactorily completed.

SIGNED _____ DATE _____

NOTES:

.1 This certificate must be submitted prior to substantial performance.

1.9 MF 180 Check List & Record – Items to be Handed to Departmental Representative

ITEM	RECEIVED	DATE
Control Drawings (Framed/Plasticized)		
Filters - Spare Sets		
Identification Schedule (Framed)		
Maintenance Program (Schedules & Cards)		
Master Key For B.A.S. Field Panels		
Test Thermometer		
Thermostat Keys		
Valve List (Framed)		

NOTES:

.1 Copies of this form to be submitted to the Departmental Representative with all items signed off prior to substantial performance.

1.10 MF 181 Check List – 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 prior to 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.

1.11 MF 182 Check List – Demonstration of Heating 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 prior to 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.

1.12 MF 188 Check List – Substantial Completion Submissions – HVAC

SECTION	ITEM	CHECKED
23 05 00	Equipment Extended Warranties Certificates	
23 05 00	Lubrication of Equipment Checklist	
23 05 93	Air and Liquid Balancing Report	
23 06 02	Testing & Balancing Certificate (MF 170)	
23 08 00	Commissioning Report and Checklists	
23 05 00	Operating & Maintenance Manuals	
23 05 00	Asbuilt Drawings for Record	
23 05 00	Maintenance Program	
23 05 00	Demonstration to Operating Staff agenda	
23 05 54	Identification Schedules	
23 06 02	Vibration Isolation Installation Certificate. (MF-175)	
23 06 02	Seismic Restraint Installation Certificate. (MF-174)	
23 31 00	Duct Cleanliness Certificate (MF 171)	
23 06 02	Demonstrations Checklists (MF 181, 182)	
23 06 02	Items handed to Departmental Representative Checklist (MF 180)	
23 06 02	Substantial Performance Certificate (MF 190)	
23 06 02	Checklist of work remaining after Substantial (MF 191).	

NOTES:

.1 This list is provided as a checklist and may not include all substantial completion requirements.

1.13 MF 190 Certificate of Substantial Performance Division 23

I hereby certify that I _____

am an employee / a principal /an agent

of _____

and have personally witnessed the following with regard to the mechanical systems work specified on the above project and that to the best of my knowledge except as noted on MF 191 (attached);

- The installation is complete and as specified.
- The systems have been commissioned and operate satisfactorily.
- Every control sequence and every control performs as specified.
- The systems are clean.
- All of the required submissions have been made to the Departmental Representative.

SIGNED _____ DATE _____

NOTES:

.1 This certificate must be completed and submitted to the Departmental Representative prior to 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.

1.14 MF 191 Check List – Work Remaining After Substantial Performance

		COMPLETION		
ITEM NO.	DESCRIPTION	CLAIMED BY	DATE	VERIFIED DATE

NOTES:

.1 This form must be filled in and submitted to the Departmental Representative prior to 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 and the Prime 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.

1.15 MF 192 Certificate of Total Performance – Division 23

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 prior to 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.

END OF SECTION

1 GENERAL

1.1 General

.1 Provide external thermal insulation for plenums and ductwork as called for.

.2 Provide internal acoustical insulation for plenums and ductwork, as called for.

.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.

1.2 Regulatory Requirements

.1 Flame spread ratings and smoke developed classifications shall be as required by the most recent B.C. Building Code 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.

1.3 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 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.

2.2 Duct Liner

.1 Rigid Acoustic 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.

.2 Flexible Acoustic 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.

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.

.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.

.4 Insulation Coating

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36, Robson White Lag.

.5 Weather Coating - vapour barrier

.1 Bakelite 110-14, Childers CHIL-PRUF CP22/23/24, Foster 60-25, Insul-Mastic 15187.

.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.

.8 Fabric Adhesive

.1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36.

.9 Fabric Coating

.1 Bakelite 120-09, Childers CP-50, Epolux Cadalag 336, Foster 30-36.

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]
Combustion intake / relief air	50	[2]
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 Acoustic Duct Liner

	Thickness	
Service	**mm**	**[ins]**
All ductwork where indicated by cross hatching	as indicated on drawings	
All exposed supply ductwork in the mechanical room (from A.H.U. discharge to duct shaft)	50	[2]

.3 Scope 3: Internal Rigid Acoustic Duct Liner

	Thickness	
Service	**mm**	**[ins]**
Cold and hot supply air plenums. Line walls, tops and bottoms from discharge dampers to supply duct connections.	50	[2]
Supply and Return air plenums within 3 meters of AHU connections.	50	[2]

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 airtight.

.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.

.2 Terminate insulation 900 mm [36"] short of duct mounted electric heating coils.

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 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, mechanical/boiler or electrical 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 SECTION INCLUDES

.1 Materials and installation of thermal insulation for HVAC piping.

1.2 RELATED SECTIONS

.1 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

1.3 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)

.1 ASTM B209M-04, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).

.2 ASTM C335-05ae1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-05, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547-07e1, Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553-02, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612-04e1, Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.2 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).

.4 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.

1.4 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as defined herein.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 00 01 50 – General Instructions (CSC).

.2 Submit following shop drawing information:

.1 Pipe insulation: manufacturer's catalogue literature

.2 Installation requirements

.3 Schedule of all piping systems and proposed insulation types, thicknesses and finishes.

1.6 MANUFACTURERS' INSTRUCTIONS

.1 Submit manufacturer's installation instructions in accordance with Section 00 01 50 – General Instructions (CSC).

.2 Installation instructions to include procedures used, and installation standards achieved.

1.7 QUALIFICATIONS

.1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, member of TIAC.

1.8 DELIVERY, STORAGE AND HANDLING

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

.2 Protect from weather and construction traffic.

.3 Protect against damage from any source.

.4 Store at temperatures and conditions recommended by manufacturer.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 or ASTM C547.

.2 Maximum "k" factor: to CAN/ULC-S702.

2.1 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

2.2 CEMENT

.1 Thermal insulating and finishing cement:

.1 Air drying on mineral wool, to ASTM C449/C449M.

2.3 VAPOUR RETARDER LAP ADHESIVE

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

2.4 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.5 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.6 JACKETS

.1 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Smooth.

.4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: Stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.7 FIRE STOPPING AND SMOKE SEAL MATERIALS

.1 References:

.1 CAN4-S115-M, 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 Work Included:

.1 Furnish all labour, material, equipment and services necessary to supply and install firestopping and smoke seals around mechanical service piping and duct penetrations through fire rated wall and floor assemblies, as indicated and as specified.

.3 Quality Assurance:

.1 The work of this section shall be carried out only by an approved specialist firm, employing skilled tradesmen experienced in firestopping and smoke seal application and approved, licensed and supervised by the manufacturer of fire stopping materials.

.2 All work to be of the highest quality according to best trade practice and in strict accordance with manufacturer's printed specifications.

.4 Submittals:

.1 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation.

.2 Submit manufacturers' product data for materials and prefabricated devices. Include assembly/location design system number references with copies of test information. Construction details should accurately reflect actual job conditions.

.3 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.

.5 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.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

.1 Pressure testing of piping systems to be complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer's instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.1 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: [A-1].

.1 Securements: Tape at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code [1501-H].

.3 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp °C	TIAC code	Insulation thickness (mm)					
Pipe sizes (NPS)			Up to 1	1¼ -2	2½-4	5-6	6½-8	>8
Hot Water Heating	60 - 94	[A-1]	25	38	38	38	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25	25	38	38

.4 Finishes:

.1 Exposed indoors: Aluminum jacket.

.2 Exposed in mechanical rooms: Canvas or Acrylic jacket.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: Water-proof aluminum jacket.

.6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.2 INSULATION PACKING OF PIPE SLEEVES

.1 Tightly pack the space between all pipe sleeves and pipe or between pipe sleeve and pipe insulation with mineral wool insulation - Thermal Ceramics to full depth of sleeve to prevent transmission of sound and/or passage of smoke.

END OF SECTION

1 GENERAL

1.1 Related Work and 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.

.1 Section 01 91 13 - Commissioning

.2 Section 01 91 41 - Demonstration and Training

.3 Section 23 05 00 - Common Work Results for HVAC

.4 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

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 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, and the verification of system operation and performance at all operational modes.

.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 Commissioning Agent shall agree to perform spot checks, where requested, in the presence of the Departmental Representative..

.4 See Division 01 specifications for project commissioning definitions, acronyms, roles and responsibilities.

1.4 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 of the following is recommended:

.1 Departmental Representative

.2 Prime Contractor's Commissioning Manager

.3 Division 23 Mechanical Trades (including Controls, Equipment Suppliers)

.4 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 project team, and the Departmental Representatives. Meeting times shall be coordinated with the Cx Manager. Suggested meeting times are immediately after regularly scheduled project meetings.

.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 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.

.4 Tentative dates for follow-up visits post-substantial.

.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, and Departmental Representative. Six [6] weeks prior to the date of scheduled substantial performance, submit a detailed commissioning 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 issue.

.2 Why - Determination and evaluation of the causes.

.3 When - Determine the time available to resolve the problem.

.4 Involve the Departmental Representative in the review of the issue 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 Departmental Representative. In the event that equipment does not meet specifications, the mechanical contractor shall 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.

.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 Equipment lubrication and prestart checks.

.3 Rotational checks.

.4 Filter systems installed and sealed in place.

.5 Adjusting vibration isolation and seismic restraints.

.6 Alignment of drives (direct and belt).

.7 Control function checks, including all alarms.

.8 Self-diagnostic packaged control items checked.

.9 All issues to be recorded, reviewed by the commissioning team, and, subsequently, corrected before proceeding to PHASE 2.

.2 PHASE 2 System startup, testing, balancing

.1 System commissioning shall include, but not necessarily be limited to:

.1 Activation of all equipment and systems.

.2 Testing and adjustment of all equipment and systems.

.3 All deficiencies are to be recorded, reviewed by the commissioning team and, subsequently, corrected. The process at the point of the deficiency, shall be repeated before proceeding to PHASE 3.

.2 Phase 2 is concluded when the installation is in full working

order and acceptable for use. The work will include the following:

.1 Balancing of the air and liquid systems as specified in this section.

.2 Set up all automatic control valves/dampers and automatic temperature control devices.

.3 Plug all air pressure and flow measuring holes.

.4 Adjust vibration isolators and earthquake restraints as necessary.

.5 Verification and certification of the sealing of all HVAC penetrations through fire separations (rated & non-rated) and sound separations.

.6 Verification of water tightness of all roof and exterior wall penetrations.

.7 Verification that all drain connections do not leak and are sloped.

.8 Testing and debugging of B.M.S. (Building Management System).

.9 Set up and test all alarm protective devices.

.10 Calibration and adjustment of the smoke venting and pressurization systems.

.3 Fine Tuning

.1 Setting up automatic controls for accurate response and precise sequencing.

.2 Setting up DDC trendlogs of relevant sensor points to allow monitoring-based commissioning efforts.

.3 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 at all operational modes. This check to include all items and functions to be later demonstrated to the Department Representative, and/or Facility Manager.

.3 PHASE 3 Verification of System Performance

.1 Verification of system performance will not commence until PHASE 2 has been totally completed. Submit 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 and timers.

.7 Manual controls/switches and timers.

.8 AHUs and associated gas fuel systems.

.9 All fan systems

.10 All pump systems

.11 Randomly selected hydronic equipment

.2 At the completion of Phase 3, the Commissioning Agent shall submit the following:

.1 A letter certifying that all work specified under this contract has been commissioned, clean and operational in accordance with the specification and drawings.

.2 A commissioning report shall include completed copies of all Phase 2 documentation outlined in the commissioning plan plus copies of start-up and test reports from specialty contractors, testing and balancing contractors and vendors and any other relevant information for inclusion in the operating & maintenance manuals.

.3 Record drawings as specified, update to include changes resulting from commissioning.

.4 A statement confirming verification of B.M.S. installation and programming.

.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. See specification section 01 91 41.

.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 follow-up visits to the site at one month and six month after substantial performance for a minimum period of two days, to ensure that the systems are operating correctly and that they are being operated and maintained properly.

.2 Provide back check of outstanding commissioning issues identified at substantial completion.

.3 Submit a report which documents any issues that have arisen and corrective action required. The report shall identify all outstanding commissioning issues that have not been resolved.

END OF SECTION

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 23 09 13 Control Devices and Instrumentation for HVAC

.2 Section 23 09 93 Control Sequences of Operation

.3 Section 23 09 94 Controls Points List for HVAC

1.2 Scope of Work

.1 The new control systems, while being stand-alone (or unitary) controllers, shall be installed as an expansion of the existing Building Automation System (BAS) installed at the Matsqui Institution.

.2 The new controllers shall be fully BACnet compatible for full integration with the existing system, and shall be fully programmable through the existing BAS front-end.

.3 The existing facility-wide DDC system is installed and maintained by "ESC Automation". However, Johnson Controls DDC panels and controllers serves the various HVAC equipment housed within the Matsqui M3 penthouse.

.4 The contractor shall coordinate with the maintaining agency listed above to ensure the proper integration of the new controllers and control points, as well as to upgrade or make additions to the Graphics User Interface (GUI) at the existing front-end.

1.3 Requirements

.1 The control system is to be fully microprocessor based.

.2 The controls system is to be complete with all necessary control components and connections to achieve the specified functions and to permit the H.V.A.C. systems to perform properly in the manner described and as hereinafter specified.

.3 The controls contractor shall furnish all materials, including all central computer hardware and software, operator input/output peripherals, standalone DDC panels, current transducers, voltage transformers, automation sensors and controls, wiring and conduit. 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.

.4 The control system is to be set up and adjusted to achieve optimum operation of the H.V.A.C. system. This includes sequencing, timing and readjustment, as required. Modifications to the sequence of operation using points indicated will not be considered as extra to the Contract. These modifications to continue through the construction period, commissioning period and warranty period as required to achieve optimum operation of the mechanical system.

.5 This Section is a performance specification clarified in certain sections to establish minimum standard of equipment, installation or level of control. The specification

describes the basic functions required but not all of the installation details or components. This Trade is expected to have sufficient experience to be able to design and estimate the cost of an appropriate control system. Materials and work necessary to achieve a satisfactory result will not be considered extra to the contract.

.6 The contractor shall review all contract documents and visit the site if possible, prior to the closing date of the tender and site confirm the requirements regarding the routing of interconnecting transmission network, etc.

.7 When preparing shop drawings, review the proposed sequences, suggest improvements and review these with the Departmental Representative.

.8 Work with the other parties involved in commissioning, assess how the programming can be modified to improve function, review this with the Departmental Representative and modify the programming as instructed.

.9 The control system shall be a modular, flexible and fully commissioned Direct Digital Control (DDC) System except that controls not scheduled on the points list may be electric. Items identified in the sequence of operation as being under DDC control but which are not included in the points list shall be included in the DDC system.

.10 Coordinate controls commissioning scope with the Commissioning Manager (prime contractor), Commissioning Authority, and Mechanical Commissioning Agent. 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.

1.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 00 01 50 General Instructions (CSC).

.2 Shop drawings shall include:

.1 Manufacturer's descriptive technical literature for all equipment and devices.

.2 Interconnection schematics.

.3 Wiring and piping diagrams.

.4 One-line diagram from sensor and control points to Field Interface device and/or standalone DDC panel including all components and cables.

.5 Terminal cabinets, including termination listing.

.6 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.

.7 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 Software and programming details.

.8 Detailed block diagrams of transmission trunk routing and configuration.

.9 Valve and damper schedules indicating size, configuration, capacity and locations. If size varies greater than 10%, obtain approval prior to submitting shop drawings.

.10 Copies of all system graphics complete with system specific point labels.

1.5 Warranty

.1 Refer to General Conditions.

.2 The system including all hardware and software components shall be warranted 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 Department 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.

2 MATERIALS

2.1 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 voltage 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, voltage transformers, current transducers (CT) and sensors etc.

.5 All wiring and conduit from power distribution system to any control devices needing power (including B.M.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 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 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

.2 Cable:

.1 Data transmission cable shall be minimum #18 gauge twisted pairs (shielding as per manufacturers recommendations).

.3 Note:

.1 Run carrier system parallel to building lines. Conduit and wiring shall appear straight with parallel.

.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 26 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.

2.2 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 Control dampers.

.2 Control Valves

.3 Pressure tappings.

.4 Static pressure sensors.

.5 Temperature sensors.

.6 Flow sensors

.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.

3 EXECUTION

3.1 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.M.S. if any equipment is not in the intended operating condition or if any analog input is not within the intended operating range.

3.2 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 this trade, unless they come with standard nameplates, shall be labelled with engraved lamicoid plastic nameplates to clearly indicate the service. Wording on nameplates shall be subject to approval by the Departmental Representative.

.3 Where "day" and "night" thermostats are adjacent to one another they shall be labelled with engraved lamicoid plastic nameplates.

.4 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.

.5 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.

3.3 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 Systems Demonstrations 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 Setup trendlogs of relevant sensor points to allow monitoring-based commissioning efforts.

.7 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.

3.4 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, and provide minimum one week notice to schedule attendance.

.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.

3.5 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 microprocessor interior and exterior surfaces.

.3 Provide signal, voltage and system isolation checks of all CPU, interface panels, multiplexing panels and peripherals.

.4 Provide mechanical equipment adjustments,

.5 Adjust trendlog intervals and data collection.

.6 Check and/or calibrate each field input/output device.

.7 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 BAS 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

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 23 09 01 Controls General

.2 Section 23 09 93 Control Sequences of Operation

.3 Section 23 09 94 Controls Points List for HVAC

1.2 Requirements

.1 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.

.2 All instruments of a particular category shall be of the same type and manufacture.

.3 All external trim material shall be completely corrosion resistant with all internal parts assembled in watertight, shockproof, vibration proof, heat resistant assembly.

.4 Use standard conduit box termination with screwdriver connector block unless otherwise specifically stated.

.5 Operating conditions 0°C to 60°C with 10-90% RH (non-condensing) unless otherwise specifically stated.

2 PRODUCTS

2.1 Control Damper 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 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.

2.2 Control Valves

.1 All characteristics of control valves shall be suited to the required application. Three-way 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 ¾ to NPS 2 shall have screened cast brass body and cast brass cage with integral seat.

.8 Valve bodies for NPS 2½ 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 Heating 3-way valve shall fail open to the heating coil.

.4 Control valves to be supplied by this trade for installation by others.

2.3 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 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.

2.4 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 Panel mounted devices:

.1 Temperature gauges and manual reset (where applicable) for:

.1 Outdoor air.

.2 Return air.

.3 Mixed air.

.4 Discharge air (each zone).

.5 Hot water supply.

.6 Hot water return (each coil).

2.5 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.

2.6 Damper Actuators

.1 General:

.1 Provide 120 or 24 volt electric or piston type pneumatic 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 23 06 00 or the drawings for schedule of control and smoke/fire dampers.

.3 Damper actuators for mixing boxes and 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 duct mounted dampers are installed, install a separate damper actuator for each damper.

.8 Where multi-section duct mounted 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.

.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.

2.7 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.

2.8 Freeze Protection

.1 Freeze protection thermostats shall be manual reset type with 6 m averaging element. Provide multiple thermostats for large duct cross sectional areas.

.2 For liquids, elements shall be rigid bulb type mounted in separable wells.

.3 Freeze protection elements shall be hard wired to the fan starter and also wired to the B.M.S. or alarm system.

2.9 Room Thermostats

.1 Minimum Requirements

.1 Adjustable sensitivity and set point.

.2 Electric.

.1 Low or line voltage as specified.

.3 Standard metal or Lexan covers.

.1 Visible thermometer (thermostats only) graduated in deg.C.

.2 Concealed set-point adjustment (or removable key adjustment).

.3 Lock key covers.

.4 Room thermostats sensors shall be tamper resistant. Suitable for CSC operations.

.2 Note:

.1 Provide a key for each instrument requiring a removable key. Obtain two signed receipts from the Departmental Representative certifying that the keys have been received. Hand one over to the Consultant.

2.10 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 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. Or multiple sensors mounted on a cable connected to provide an average temperature reading

.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.

2.11 Variable Speed (Frequency) 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 0° C to +40° 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 Over-temperature 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 3 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 screw driver. 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 26 and all control wiring by the Controls Contractor.

.19 The manufacturer'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 Consultant 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.

2.12 Variable Speed (Frequency) Drive Controller – Packaged

.1 Variable speed motor drive controllers have been specified to be provided as part of air handling units and pumps packages, to be supplied by the mechanical contractor, wired and connected by Division 26 (Power Wiring) and control wiring by the controls subtrade (under this contract). Refer to individual building contract document for specified product information, etc.

3 EXECUTION

3.1 General

.1 All equipment shall be installed according to manufacturers' published instructions.
.2 Temperature Sensors, Thermostats and all other wall mount sensors:
.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 Install corridor instruments at a height of 2.1 m above the finished floor.
.4 Locate instruments in the same vertical centreline as light switches.
.5 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).
.6 Install protective metal guards on instruments in areas where they may be subject to damage (loading areas, gymnasiums, workshops, public corridors and storage areas). Bolt guards, independent of instruments to separate baseplates. Provide backing in wall for securing mounting bases.
.7 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.

.8 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.

.3 Temperature Transmitters, Humidity Transmitters, 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 and tubing within panels to be located in trays or individually clipped to back of panel, and clearly identified.

.4 All field devices to be properly identified.

.5 Mount pneumatic instruments on standard wall mounting box or pipe head rough-in fittings which shall be fastened to structure.

.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 consultant for approval. The consultant will verify results at random. Provide all testing equipment necessary. Provide manpower necessary to assist consultant's verification.

End of Section

1 GENERAL

.1 The new system shall be fully integrated with the existing system and operator interface shall be through the existing operator's work station located in the facility.

2 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.

.1 Section 23 09 01 Controls General

.2 Section 23 09 13 Control Devices and Instrumentation

.3 Section 23 09 94 Controls Points List for HVAC

.4 Section 23 73 10 Air Handling Units

3 EXECUTION

3.1 HVAC Control Objectives:

.1 Program the system to meet the following objectives:

.1 Temperature:

.1 Control the temperature in each occupied space.

.2 Ventilation:

.1 Control the system's minimum outdoor air intake and the supply to each zone to meet code ventilation requirements under all operating conditions.

.3 Energy:

.1 Provide no more heating than is essential during Normal Operation.

.4 Operation:

.1 Systems shall remain under BMS control during all operating conditions.

.2 Setup trendlogs to accommodate monitoring-based commissioning.

.3 Integrate into the existing Sequence of Operation. Modify and fine tune as needed during commissioning.

3.2 Schedule:

.1 The existing building occupancy schedule shall be maintained. The system will be energized by the DDC system weekly schedule (24-hour operation).

3.3 Monitoring:

.1 The BMS monitors the following conditions and parameters as a minimum:

.1 All damper and valve positions

.2 All temperature sensors

.3 All fan operation and status

.4 Differential pressure drop across the filter sections

3.4 Alarms and Safeties:

.1 The existing fire alarm strategy shall be maintained and carried over to the new

AHUs operation. See electrical specifications.

.2 The existing AHU alarms shall be maintained and carried over to the new AHU.
- .1 Supply Fan Failure
- .2 Exhaust Fan Failure
- .3 High and Low Supply Static Pressure
- .4 High and Low Supply Air Temperature
- .5 Freeze Condition
- .6 Additional alarms as noted in the points list (see 23 09 94).

4 EQUIPMENT AND SUBSYSTEMS CONTROL SEQUENCES

4.1 AHU and EF Systems (Typical)

.1 Scope:
- .1 Variable Air Volume & Exhaust Fans Control

.2 Components:
- .1 Air Handling Units and Exhaust Fans. The following air handling units will have this typical control strategy:
  - .1 Air handling unit AHU102N serves Building M3 – North Wing
    Exhaust air unit EF-102N exhausts from Building M3 – North Wing
  - .2 Air handling unit AHU102S serves Building M3 – South Wing
    Exhaust air unit EF-102S exhausts from Building M3 – South Wing
  - .3 Air handling unit AHU102W serves Building M3 – West Wing
    Exhaust air unit EF-102W exhausts from Building M3 – West Wing
  - .4 Air handling unit AHU-102E serves Building M3 – East Wing
    Exhaust air unit EF-102E exhausts from Building M3 – East Wing

.3 Sequenced Start Times:
- .1 Modify the AHU system start times for each Wing.
  - .1 Adjust to 8 minute (adjustable) interval for each AHU. No two supply fans shall ramp up at the same time.
  - .2 Modify AHU ramp up times during commissioning. Record the setpoints for future reference.

.4 Normal Operation:
- .1 Upon system activation, the supply fan variable frequency drives will ramp up to maintain a static pressure setpoint of 250 pascals (to be adjusted during balancing).
- .2 The exhaust fan will ramp up with the supply fan to maintain 90% volume of the supply fan.

  Note: The exhaust fan speed each unit will be set up based on air balancing volumes to maintain building pressurization and exhaust air balance (to be done during air balancing).

4.2 Air Handling Units Control (Typical):

.1 Scope:
- .1 AHU-x, sensors, and system components

.2 Components:
- .1 Supply Fan and VFD
- .2 O/A damper MDS-x
- .3 Filter pressure differential sensor
- .4 Heating Coil HC-x
- .5 Control valve CV-HCx
- .6 Temperature sensors for O/A, S/A
- .7 Room temperature sensor (connect to existing)

.3 Normal Operation
- .1 The AHU shall run on a scheduled operation (adjustable) for occupied mode and unoccupied mode.
- .2 Occupied Mode:
  - .1 Supply fan shall run continuous at variable speed air flow. Fan speed shall modulate from 75% to 100% capacity.
  - .2 The O/A damper MDS-x shall be set at 100% open.
  - .3 The heating coil valve will modulate to maintain a supply air temperature setpoint (between 12.7 degC and 13.9 degC) which will be based on the outdoor air temperature.
- .3 Fail Safe Mode (Unit is off)
  - .1 The system will be in the following "fail safe" modes when the air handling unit is off:
  - .2 Supply Fan: Off
  - .3 Exhaust Fan: Off
  - .4 Heating Coil Valve: Maintains 13.9 degC Supply Air Temperature
  - .5 The O/A damper MDS-x shall be closed.

.4 Freeze Protection:
- .1 A freeze protection controller with a 6 m sensing element supported downstream of the coil section shall cause the system to shut down upon sensing air temperature of 5 degC or lower. Reset to be at sensing device.
  - .1 A global variable freeze trip is tripped upon the supply air sensor sensing a low temperature (set at 5 degC).
  - .2 If the global variable freeze trips, the supply fan stops, the exhaust fan stops and the heating valve opens 100% to the coil.
  - .3 When the air handling unit is off (see Fail Safe Mode), the heating valve will control to maintain a supply air temperature setpoint of 13.9 degC.

4.3 Existing Hot Water Heating System

.1 Hot water heating supply is generated by the existing hot water heating system (Matsqui central heating plant).

.2 Hot water heating supply is provided at 82.2 degC.

.3 Existing Duct Reheat Coil operation shall remain.

END OF SECTION

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 23 09 01 Controls General

.2 Section 23 09 13 Control Devices and Instrumentation for HVAC

.3 Section 23 09 93 Control Sequences of Operation

1.2 Scope of Work

.1 The following points list indicates the input and output points that shall be connected to the Building Automation System (BAS). 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.

.2 All points associated with one mechanical system shall be connected to the same Local Controller (e.g. AHU Controller, Unitary Controller, or Local Programmable Controller). Control loops and sequences are usually programmed into and determined at the local controller level. However, all listed points associated with the local controller shall be available to the BAS for either monitoring, overrides, or for changes to set-points and scheduling.

.3 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 Operators Work Station (OWS).

1.3 Device Legend

.1 RTS = Room Temperature Sensor
.2 DTS = Duct Temperature Sensor
.3 ITS = Immersion temperature Sensor
.4 ATS = Averaging Duct Temperature Sensor
.5 OTS = Outdoor Temperature Sensor
.6 DPT = Differential Pressure Transmitter
.7 SPT = Static Pressure Transmitter
.8 PSW = Pressure Switch
.9 TSW = Temperature Switch
.10 CR = Current Relay
.11 CT = Current Transducer
.12 DAF = Duct Air Flow Sensor
.13 FSW = Flow Switch
.14 ESW = End Switch
.15 ER = Electric Relay
.16 DME = Damper Actuator Modulating Electronic
.17 DTE = Damper Actuator Two Position Electronic
.18 DMI = Damper Actuator Modulating Incremental Control
.19 BCM = Burner Control Modulating Electronic

.20 BCS = Burner Control Staging Electronic
.21 VTE = Valve 2 Position Electronic
.22 VME = Valve Modulating Electronic
.23 VSD, VFD = Variable Speed Device, Variable Frequency Drive

1.4 **Table Legend**

.1 **DI** = DIGITAL INPUT; **DO** = DIGITAL OUTPUT; **AI** = ANALOG INPUT; **AO** = ANALOG OUTPUT; **H** = HIGH ALARM; **L** = LOW ALARM; **S** = STATUS ALARM

1.5 **INPUT/OUTPUT POINTS LIST**

.1 Provide full integration into the existing DDC and connect to all new points.

1.6 **Systems: Air Handling Unit – Typical of 4**

		INPUT		OUTPUT		Non		
AHU Points	**Point Description**	**DI**	**AI**	**DO**	**AO**	**DDC**	**Alarm**	**Notes**
SF-x	S/A fan VFD status/speed		X				FAIL	
SF-x	S/A fan motor VFD enable				X			VFD
MDS-x	O/A damper status/position		X				FAIL	DME
MDS-x	O/A damper				X			DME
	O/A temperature		X					DTS
	Mixed air temperature		X					DTS
	S/A temperature		X				HI	DTS
	*Room temperature		X				HI/LO	RTS*
	Room temperature set-point		X			X		
	Air filters differential pressure status	X					HI	DPT
	Freeze stat	X					X	ATS

Notes: *Connect to existing room temperature sensor.

1.7 **Systems: Hot Water Heating (Glycol) Piping – Typical of 4**

		INPUT		OUTPUT		Non		
Point	**Point Description**	**DI**	**AI**	**DO**	**AO**	**DDC**	**Alarm**	**Notes**
CV-HCx	3-way control valve for HC-x				X			VME
CV-HCx	3-way control valve for HC-x status/position		X					VME

1.8 **Existing Exhaust Fans**

		INPUT		OUTPUT		Non		
Point	Point Description	DI	AI	DO	AO	DDC	Alarm	Notes
EF-x	Exhaust fan VFD		X		X			VFD
EF-x	Exhaust fan status	X					FAIL	CR

Notes: *Connect to all existing exhaust fan system points.

1.9 **Equipment Tags for Major Equipment (For Reference)**

AIR HANDLING UNIT SYSTEMS					
AHU Variable Frequency Drive	AHU Supply Fan	AHU O/A Damper	AHU R/A Damper	AHU Heating Coil	AHU Heating Coil Control Valve
VFD-x	SF-x	MDS-x	MDR-x	HC-x	CV-x
VFD-102N	SF-102N	MDS-102N	MDR-102N	HC-102N	CV-HC102N
VFD-102S	SF-102S	MDS-102S	MDR-102S	HC-102S	CV-HC102S
VFD-102W	SF-102W	MDS-102W	MDR-102W	HC-102W	CV-HC102W
VFD-102E	SF-102E	MDS-102E	MDR-102E	HC-102E	CV-HC102E

EXHAUST FAN SYSTEMS		
New VFD for Existing Exhaust Fan	New Tag No. for Exhaust Fan	Original Tag No. for Exhaust Fan
VFD-EF-x	EF-x	EF-x
VFD-EF-102N	EF-102N	EF4-N
VFD-EF-102S	EF-102S	EF2-S
VFD-EF-102W	EF-102W	EF3-W
VFD-EF-102E	EF-102E	EF1-E

END OF SECTION

1 GENERAL

1.1 Related Work

.1 Section 23 05 49 Seismic Restraints.

.2 Section 23 09 01 Controls General.

1.2 Reference Standards

.1 Do all piping system work in accordance with ASME/ANSI B31.9 code and CSA B51.

1.3 Regulatory Requirements

.1 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".

.2 All field welding to be in accordance with the procedures of CSA-W117.2 and the current edition of ASME/ANSI B31.1 or B31.9 Code.

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.

2 PRODUCTS

2.1 General

.1 All products shall be registered with the regulatory authority in accordance with CSA B51.

2.2 Pipe

.1 Steel Pipe:

.1 to NPS 10, Schedule 40 to ASTM A53 Grade B or NPS 3/4 to NPS 2 to ASTM A795, Schedule 5, suitable for Pressfit.

.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 (glycol).

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, Pressfit in applicable applications.

.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 Victaulic Pressfit fittings with grade "E" EPDM O-rings may be used on hot water heating up to 110°C [230°F] working temperature, glycol heating, glycol heat recovery, chilled water, heat pump water, condenser water-closed circuit systems.

.5 Flange Bolts and Nuts, carbon steel: to ANSI B18.2.1 and ANSI B18.2.2.

.6 Flange gaskets:

.1 Up to 860 kPa [125 psig] system pressure - non-asbestos gaskets for mating surfaces.

.2 Over 860 kPa [125 psig] system pressure - stainless steel spiral wound non-asbestos gaskets.

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 Fittings for roll grooved piping: Ductile iron to ASTM 536; wrought steel to ASTM A234; or where cast or wrought pattern is not available factory fabricated and tested to ASTM A53.

.1 Fittings shall be of the same manufacturer as the adjoining couplings.

2.5 Valves General

.1 Wherever possible all valves shall be of one manufacturer.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body. All valves must be suitable in all respects for service used.

.3 Include lock shield handles where shown or noted.

2.6 Gate Valves

.1 NPS 2 and under, screwed:

.1 Bronze body, rising stem, solid wedge disc, union or screwed bonnet.

2.7 Globe Valves

.1 NPS 2 and under, screwed:

.1 Bronze body, rising stem, renewable composition or bronze disc, union bonnet.

2.8 Ball Valves

.1 NPS 2 and under, screwed:

.1 Forged brass body, threaded cap, chrome plated ball, PTFE seats, blow out proof stem.

.2 Ball valves for isolation service shall have a large/full port.

.3 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.

.4 Acceptable Products:

.1 Class 600 W.O.G. [4140 kPa] - Crane F9202, Grinnell 3700, Kitz 58, Nibco T-585-70, Red-White/Toyo 5044A, Victaulic 722.

2.9 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.

2.10 Swing Check Valves

.1 NPS 2 and under, screwed:

.1 Bronze body, bronze swing disc, screw in cap, regrindable seat.

2.11 Drain Valves

.1 Globe type, bronze body with bronze trim and composition disc.

2.12 Control Valves

.1 See Section 23 09 01 Controls General.

3 EXECUTION

3.1 Piping

.1 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly. Remove welding slag or other foreign material from piping.

.2 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.

.3 Screw, or weld, fittings (unless otherwise specified) for all piping systems up to NPS 2.

.4 Install piping to conserve headroom and space. Run exposed piping parallel to walls. Do not block equipment access panels.

.5 Maintain a minimum of 25 mm [1"] space between adjacent flanges or pipe insulation, whichever has the larger diameter.

.6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.7 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.

.8 Use long radius elbows.

.9 Remake leaking joints using new materials, do not caulk or cement leaking threaded joints.

.10 Use eccentric reducers at pipe size changes, flush on top side, to permit positive venting and drainage.

.11 Do not use thread protection couplings, close nipples, running nipples or street elbows.

.12 Avoid locating water and drain piping over electrical equipment. Where this is unavoidable, provide galvanized drip pans under such pipe and weld piping and fittings. Provide drain and piping from drip pans to satisfactory floor drain. Drainage for glycol filled piping shall be collected separately. Do not create tripping hazards.

.13 Bull head tees shall not be used for converging flows.

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].

3.3 Connections to Equipment and to Existing Piping

.1 Install unions, grooved couplings, or flanges at connections to all equipment and specialty components and at all connecting points to existing systems which, for reasons of separation for testing, will require to be blank flanged or capped.

.2 Connect to equipment in accordance with manufacturer's instruction unless otherwise noted.

.3 Arrange piping connections to allow ease of access and for removal of equipment.

.4 Align and independently support piping connections adjacent to equipment to prevent piping stresses being transferred.

.5 Do not reduce equipment connection sizes by bushing.

.6 Branch connections to existing steel piping may be made using double strap service saddles.

.7 Where shut down of a service is not possible, a hot-tap process shall be used for the tie-in connection of the services. The hot-tap welding in-place requires special equipment and the services of a highly skilled journeyman welder. Submit qualifications of journeyman welder prior to commencing work.

.8 When connecting to an existing antifreeze (or glycol) system, the antifreeze solution shall be drained into temporary storage tanks. Do not drain into sanitary / storm system.

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.

.4 Where item being drained is under pressure, provide a deep seal trap.

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. Pay particular attention to piping running horizontal across building expansion joints and provide adequate expansion and contraction for all such piping.

.2 Only major expansion configuration and fittings have been shown on the drawings. Provide all required additional compensators, loops and swing connections.

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

.4 Expansion loops shall be of all welded construction with long radius elbows.

.5 Install expansion loops, cold sprung 50% of the calculated expansion.

.6 Install at least three [3] elbows in all branch connections. Where space does not permit 3 elbows, install braided flexible pipe connectors in accordance with manufacturer's 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 Install balance fittings or valves in the return piping connections to each terminal heating and cooling unit - eg. radiators, unit heaters, fan coil units, heating and cooling coils.

.5 Install radiator valves in the supply connections to each convection heating element.

.6 Provide valves upstream of all meters, gauges, automatic air vents, etc. for isolation purposes.

3.7 Piping Tests

.1 Notify the Consultant 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 New connections to existing piping shall be warranted.

.9 Initial Hydrostatic test:

.1 150% of working pressure, but not less than 860 kPa [125 psig] for 1 working day.

.10 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.

3.8 Flushing and Cleaning

.1 After completion of all piping tests, clean and flush all piping systems to remove all internal dirt, millscale, rust, piping dope, pipe reamings and slag. On completion of flushing, remove, clean and reinstall all strainer baskets.

3.9 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 Refer to Section 23 07 13 Thermal Insulation for Ducting

.2 Refer to Section 23 31 14 Metal Ducts Low Pressure to 500Pa

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 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 DUCTWORK - 500 PA [2" W.G.] STATIC PRESSURE

.1 As per Section 23 31 14.

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 ductwork is indicated 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.

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 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs as required to suit site conditions.

.8 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.

.9 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 bottom duct panels when ductwork is handling moisture.

.12 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.

.13 Support duct risers at their base and at each floor and at not greater than 3.7 m [12 ft] intervals.

.14 Arrange ductwork and plenums so that duct and plenum mounted equipment can be easily removed.

.15 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.

.16 During construction, protect openings in ductwork, from dust infiltration, by covering with polyethylene, and protect floor outlet duct openings with metal caps.

.17 Where ductwork is required to pass through open web steel joists, coordinate with the joist fabricator before fabricating ductwork.

.18 Where ducts penetrate roofs, install sleeves and roof curb c/w flashing and counterflashing. Pack sleeves in roof with fibreglass insulation.

.19 Under floor 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 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 All outdoor air ducts.

.5 All relief air 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, and air terminals.

.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 re-cleaned.

.6 Submit a report from the cleaning agency that certifies all specified air systems have been cleaned.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

1.2 RELATED SECTIONS

.1 Section 23 07 13 Thermal Insulation for Ducting

.2 Section 23 31 00 Ductwork and Plenums

1.3 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.

.2 ASTM A653/A653M-09a, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 National Fire Protection Association (NFPA).

.1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-05, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.

1.4 SUBMITTALS

.1 Submittals: in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF. The PDF will be used for insertion into the Operating and Maintenance and/or Commissioning Manuals.

.3 Submit the following shop drawings:

.1 Fabrication drawings for exhaust hoods. Indicate metal material, thickness and all dimensions.

.2 Perforated ductwork. Include drawings and calculations showing the designed air distribution along the duct length.

.4 Quality Control Check Sheets

.5 Closeout Submittals: Provide all applicable close-out submittals per paragraph 1.18 "Closeout Submittals" of section 00 01 50 – General Instructions (CSC).

1.5 QUALITY CONTROL

.1 General:

.1 Contractor to be responsible for quality control of the products and installation in this section.

.2 Submit all information and material required for the Quality Management System, in accordance with Section 00 01 50 General Instructions (CSC).

.3 Quality Control Program Submittals:

.1 Quality Control Check Sheet

.4 Quality Control Check Sheet:

.1 Prepare and maintain Quality Control Check Sheets.

.2 Check sheet to be kept on site and be made available for review by the Departmental Representative at any time.

.3 Check sheets to be filled in and submitted for review, prior to substantial completion.

.4 Check sheets to include the following information:

.1 Random checks of duct gauge compared to SMACNA requirements.

.2 Duct joints

.3 Tape and duct sealant quality.

.4 Smooth radius elbows.

.5 Type of hangars.

.6 Corrosion resistant hangars in Level 0.

.7 Support spacing as specified.

.8 Identification

.9 Duct leakage test report

.10 Duct cleaning report

.11 Visual inspection of duct cleanliness (interior and exterior).

.12 Damage to ductwork.

.5 For each tabulated item, state the following:

.1 Does the item comply with the specification? Yes/No/Not Applicable.

.2 Identify any areas of non compliance and the proposed action to make it compliant.

1.6 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 Ductwork used on this project shall be clean and free from scale, corrosion and deposits. All ductwork shall be degreased and wiped clean of all oil and other surface films with appropriate solvents prior to installation.

.6 All ductwork shall be delivered clean to the site and maintained in clean condition. Dirty ductwork shall be removed from site.

.7 Where welded ductwork is indicated, the welding shall be continuous. Tack welding is unacceptable except as specifically noted. Paint damaged areas with zinc coating after welding.

.8 Provide seismic restraints for ductwork in accordance with SMACNA "Guidelines for seismic restraints of mechanical systems and plumbing piping systems".

Part 2 Products

2.1 GALVANIZED STEEL

.1 Galvanized steel shall have a 380 g/sq.m. galvanizing coat both sides to ASTM A525 G90.

.2 Thickness to SMACNA requirements.

2.2 DUCTWORK AND PLENUM PRESSURES

.1 Provide ductwork and plenums fabricated from galvanized steel for the static pressure categories listed below.

.1 500 Pa static pressure

.1 All supply, return and exhaust air ductwork and plenums, unless otherwise specified.

.2 All outdoor air ductwork and plenums, except as otherwise specified.

2.3 DUCTWORK - 500 Pa STATIC PRESSURE

.1 Provide galvanized iron ductwork for system operating pressures 500 Pa 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 At least two opposite faces of all rectangular ductwork must be joined together using a type of joint, which cannot pull apart.

.4 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.

.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, but excluding beaded crimp joints and snaplock seams.

.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 ducts. 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. 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 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	B

.2 Seal classification:

.1 Class B: longitudinal seams, transverse joints and connections made airtight with sealant, tape or combination thereof.

2.5 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.6 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows.

.1 Rectangular: centreline radius for standard rectangular elbows shall be 1.5 times duct width, unless shown otherwise.

.2 Round: smooth radius. Centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular with single thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct, 45 degrees entry on branch.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full radiused elbows, or as indicated.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.7 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation.

.2 Fire stopping material and installation must not distort duct.

2.8 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.9 DUCTWORK – OUTDOORS

.1 Not used.

2.10 HANGERS AND SUPPORTS

.1 Hangers and Supports as follows:

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500 mm.

.2 Hanger configuration: to ASHRAE and SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to following table:

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

2.11 UPPER HANGER ATTACHMENTS:

.1 Upper attachment structural: suspension from lower flange of I-Beam:

.1 Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, ULC listed to MSS-SP58 and MSS-SP69.

.2 Upper attachment structural: suspension from upper flange of I-Beam:

.1 Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut ULC listed.

.3 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate, ULC listed to MSS SP69.

.3 Concrete inserts for existing concrete slabs: Refer to Section 03 30 00 – Cast-in-Place Concrete for requirements.

.4 Steel Joist:

.1 Steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.

.5 Steel Channel or Angle (bottom):

.1 Universal channel clamp.

.6 Steel Channel or Angle (top):

.1 Steel jaw, hook rod with nut, spring washer and plain washer.

2.12 COUNTER FLASHINGS

.1 Counter flashings - galvanized sheet steel of 0.76 mm (22 ga) minimum thickness.

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 centres and shall turn through 90 deg., with a radius of 50 mm. 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.

.6 For 500 Pa pressure systems, install tie rods to limit the maximum unsupported vane length to 914 mm. Refer to Fig. 2-4 of the SMACNA Duct Standards.

.7 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs as required to suit site conditions.

.8 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.

.9 Cross-break or bead all metal duct panels unless otherwise noted.

.10 Do not cross-break bottom duct panels when ductwork is handling moisture.

.11 Roof mounted ducts shall have standing seams and shall be sealed weather tight.

.12 Grade all ductwork handling moisture, a minimum of 1:120 back to the source or at low points in the ductwork, provide a 150 mm deep drain sump and 32 mm dia. drain connection with deep seal trap and pipe to drain.

.13 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 Silicone Sealant Then install the top panels and seal the top panel seams and joints.

.14 Provide moisture collection sections inside all louvres for outside air and exhaust air.

.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 intervals.

.17 Prior to the fabrication of ductwork, co-ordinate and field measure all ductwork to ensure a complete installation respecting all other services. Provide all necessary fittings, offsets, and alternate construction methods to facilitate the installation.

.18 Arrange ductwork and plenums so that duct and plenum mounted equipment can be easily removed.

.19 Arrange access doors so that they open against the airflow and static pressure.

.20 Provide necessary baffling in manufactured or built-up mixed air plenums to ensure good mixed air temperature with variations of not more than ± minus 5°C under all operating conditions.

.21 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 thick galvanized steel band tightly fitted around insulation and then caulk to band.

.22 During construction, protect openings in ductwork, from dust infiltration, by covering with polyethylene, and protect floor outlet duct openings with metal caps.

.23 Where ductwork is required to pass through open web steel joists, coordinate with the joist fabricator before fabricating ductwork.

.24 Where ducts penetrate roofs, install sleeves and roof curb c/w flashing and counterflashing. Pack sleeves in roof with fibreglass insulation.

.25 Provide drip pans under piping and shields for protection of electrical panels and equipment.

.26 Unless noted otherwise, line all builder's shafts and air plenums used as ducts and plenums with sheet metal.

.27 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct. Ensure diffuser is fully seated.

.28 Install breakaway joints in ductwork on both sides of fire separation.

.29 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.30 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: as follows:

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

3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Outdoor air intake.

.2 Ductwork installed outdoors

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Solder or weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards drain in section of waterproof duct.

.1 Slope header ducts down toward risers.

.4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and trap primer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for sheetmetal duct accessories including flexible connections, access doors, vanes and collars.

1.2 REFERENCES

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

1.3 SUBMITTALS

.1 Submittals: in accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Submit all information and data in both printed paper format and PDF. The PDF will be used for insertion into the Operating and Maintenance and/or Commissioning Manuals.

.3 Submit the following shop drawings:

.1 Duct Connectors

.2 Duct and plenum sealers

.3 Access doors in ducts and plenums.

.4 Instrument test ports.

.5 Spin-in Collars

.4 Quality Control Check Sheets

.5 Closeout Submittals: Provide all applicable close-out submittals per section 00 01 50 – General Instructions (CSC).

1.4 QUALITY CONTROL

.1 General:

.1 Contractor to be responsible for quality control of the products and installation in this section.

.2 Submit all information and material required for the Quality Management System, in accordance with Section 00 01 50 General Instructions (CSC).

.3 Quality Control Program Submittals:

.1 Quality Control Check Sheet

.4 Quality Control Check Sheet:

.1 Prepare and maintain Quality Control Check Sheets.

.2 Check sheet to be kept on site and be made available for

review by the Departmental Representative at any time.

.3 Check sheets to be filled in and submitted for review, prior to substantial completion.

.4 Check sheets to include the following information:

.1 Ducts sealed all joints.

.2 Flexible connectors at all fan inlets, outlets and as shown.

.3 Access doors at all listed locations and where shown.

.5 For each tabulated item, state the following:

.1 Does the item comply with the specification? Yes/No/Not Applicable.

.2 Identify any areas of non compliance and the proposed action to make it compliant.

Part 2 Products

2.1 GENERAL

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

2.2 DUCT CONNECTORS – VIBRATION ISOLATION

.1 Provide flexible duct connections to provide vibration isolation at all duct and plenum connections to fan and air handling units. See Figure 2-19 SMACNA Duct Standards.

.2 Minimum Requirements:

.1 Pre-assembled 75 mm minimum long flexible connection with 75 mm long, 0.62 mm galvanized steel duct connectors on each side of the flexible connection. Flexible connector - fiber glass fabric with elastomer coating.

.3 Centrifugal fans with 900 mm diameter and larger fan wheels, use 150 mm long flexible connection.

2.3 DUCTWORK AND PLENUM SEALERS

.1 Provide duct sealing compounds for use in fabrication of all ductwork and plenum joints.

.2 Low Pressure Systems - SMACNA Seal Classification B. Medium and High Pressure Systems - SMACNA Seal Classification A.

.3 Where accessible, apply sealer to inside of joints on ducts and plenums under positive pressure - e.g. on the discharge side of fans.

.4 Apply sealer to outside of joints on ducts and plenums under negative

pressure - e.g. on the suction side of fans.

2.4 SEALANT AND TAPE

.1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C. shall meet VOC limits per SCAQMD Rule 1168.

.2 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.5 ACCESS DOORS IN DUCTS AND PLENUMS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:

.1 Up to 300 x 300 mm: two sash locks complete with safety chain.

.2 301 to 450 mm: four sash locks complete with safety chain.

.3 451 to 1000 mm: piano hinge and minimum two sash locks.

.4 Doors over 1000 mm: piano hinge and two handles operable from both sides.

.5 Hold open devices.

.6 300 x 300 mm glass viewing panels.

2.6 INSTRUMENT TEST PORTS

.1 1.6 mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

2.7 SPIN-IN COLLARS

.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

.2 Sheet metal thickness to correspond with round duct standards.

2.8 CONTROL DAMPERS

.1 O/A and R/A openings shall be low-leak dampers (O/A damper shall be insulated), Damper shall be opposed blade type. The frame shall be fabricated from 16 gauge galvanized steel. Damper shall meet the leakage requirements of ASHRAE Std. 90.1 and of the International Energy Conservation Code by leaking less than 3 CFM/sq. ft. at 1" of static

pressure, and shall be AMCA licensed as a Class 1A damper.

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 DUCT CONNECTORS – VIBRATION ISOLATION

.1 Install in following locations:
- .1 Inlets and outlets to supply air units and fans.
- .2 Inlets and outlets of exhaust and return air fans.
- .3 As indicated.

.2 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:
- .1 Ducting on sides of flexible connection to be in alignment.
- .2 Ensure slack material in flexible connection.

.6 Ensure flexible duct connectors do not reduce duct free area on suction side of fans.

3.3 SEALING AND TAPING

.1 Apply sealant to outside of joint to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.4 DUCT AND PLENUM ACCESS

.1 Locations: Provide access doors and panels as follows:
- .1 Doors: where shown on the drawings.
- .2 Panels:
  - .1 Every 12 m on all ductwork.
  - .2 At the base of each duct riser.
  - .3 Both sides of equipment blocking the duct e.g.
    - .1 Air flow measuring stations
    - .2 Coils
  - .4 At or to one side of other equipment in duct e.g
    - .1 Backdraft dampers (counter weight side)
    - .2 Balance dampers serving multiple outlets/inlets

.3 Bearings (fans/motors)
.4 Control/operating dampers
.5 Control sensors
.6 Fire dampers (rectangular ducts and round ducts 330 mm dia. and larger - latch side)
.7 Heat detectors (upstream from device)
.8 Smoke detectors (upstream from device)

.5 Panels need not be provided where access is available through a door or a register mounted on the side of the duct.

.3 Patches:

.1 Where required for cleaning and where access panels are not specified, e.g. on both sides of turning vanes.

.4 Flexible duct - on round duct and round fire dampers up to 300 mm dia.

.2 Seal frames airtight.

.3 Install so as not to interfere with airflow.

.4 Install to provide easiest possible access for service and cleaning.

.5 Do not use sheet metal screws for attaching access panels to ductwork.

.6 Round ducts 330 mm dia. and larger shall include a short collar for the installation of access panels.

.7 Small rectangular ducts shall be transitioned to a minimum dimension across the duct of 330 mm for the installation of access panels.

.8 Provide retaining chains on panels 2.1 m above floor, and higher.

3.5 INSTRUMENT TEST PORTS

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Locations:

.1 For traverse readings:

.1 Ducted inlets to roof and wall exhausters.

.2 Inlets and outlets of other fan systems.

.3 Main and sub-main ducts.

.4 And as indicated.

.2 For temperature readings:

.1 At outside air intakes.

.2 In mixed air applications in locations as approved by Departmental Representative.

.3 At inlet and outlet of coils.

.4 Downstream of junctions of two converging air streams of different temperatures.

.5 And as indicated.

3.6 SPIN-IN COLLARS

.1 Provide spin-in collar and balancing damper for all round duct takeoffs from a main duct.

3.7 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for heating and ventilating air handling unit.

.2 This section applies to AHU-102N, AHU-102S, AHU-102W, and AHU-102E which serves the M3 building.

1.2 RELATED SECTIONS

.1 Sections 23 05 48 – Vibration and Seismic Controls

.2 Sections 23 05 49 – Seismic Restraints

1.3 REFERENCES

.1 ANSI/UL 1995 B-1998, Standard for Heating and Cooling Equipment.

.2 CSA C22.1 HB-09, Canadian Electrical Code Handbook.

.3 NFPA 90A-09, Standard for the Installation of Air Conditioning and Ventilating Systems.

.4 AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings

.5 AMCA Publication 99 – Standards Handbook

.6 AMCA Standard 203 – Field Performance Measurement of Fan Systems

.7 AMCA Standard 210 – Laboratory Methods of Testing Fans for Performance Rating

.8 AMCA Standard 300 – Reverberant Room Method for Sound Testing of Fans

.9 AMCA Standard 500 – Laboratory Methods for Testing of Dampers and Louvers

.10 ARI Standard 410 – Forced Circulation Air-Cooling and Air-Heating Coils

.11 ANSI/ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality

.12 ANSI/ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential

.13 ASTM A-653 – Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process

.14 NEMA MG1 – Motors and Generators

.15 NFPA 70 – National Electric Code

.16 NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems

.17 UL 900 – Test Performance of Air Filters

.18 UL 1995 – Standard for Heating and Cooling Equipment

1.4 SUBMITTALS

.1 Submittals: In accordance with the Submittal Procedure requirements in Section 00 01 50 – General Instructions (CSC).

.2 Shop Drawings:

.1 Submit shop drawings to indicate project layout and dimensions; indicate:

.1 Unit drawing showing dimensions, internal and external construction details, insulation, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes and individual components (for knockdown field installation); include mass distribution drawings showing point loads.

.2 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.

.3 Piping, valves, fittings shipped loose showing final location in assembly.

.4 Control equipment shipped loose, showing final location in assembly.

.5 Detailed composite wiring diagrams for electrical and control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.

.6 Fan performance curves.

.7 Details of vibration isolation.

.8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.

.3 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals: Provide all applicable close-out submittals per section 00 01 50 – General Instructions (CSC).

.1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.

.2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

Part 2 Products

2.1 Air Handling Units AHU

.1 General

.1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

.2 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be

exceeded, and where specifically defined, sound power levels must not be exceeded.

.3 Unless stated otherwise, air-handling units are to be shipped to the job in as "modular" and/or "knockdown", for final field assembly. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL prior to shipment. Note, "Modular" delivered components are essentially "Knockdown" components that have been partially assembled prior to being shipped to the site – this may reduce field installation time.

.4 Pre-wired air handling units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the Canadian Electrical Code.

.5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.6 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment.

.7 Tags and decals to aid in service or to indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and Maintenance manuals shall be furnished with each unit.

.2 Cabinet Construction"

.1 Site Assembled units: Units shall be provided by a manufacturer in the business of producing factory and site assembled custom air handling equipment and shall be specifically engineered for final assembly at the jobsite. Site assembly shall be accomplished using the same procedures and techniques as would be used by the manufacturer in the factory and shall yield the same performance characteristics. Site assembly techniques that negate thermal break or other performance characteristics shall not be accepted.

.2 The installing contractor shall provide technicians for training at the AHU manufacturer's facility prior to equipment shipment and/or site assembly shall be supervised by a direct employee of the AHU manufacturer or by a manufacturer certified technician. All unit warranty coverage shall be the same as for a factory assembled unit.

.3 Complete units shall be shipped, broken down into individual panel and component form and all pieces shall be engineered for site assembly with no disassembly required. Dimensions and weights of critical sized components shall be provided at time of project submission, for review by the engineer and contractor.

.4 All AHU components, assembly instructions, gasket and assembly hardware shall be provided by the AHU manufacturer. Assembly instructions shall include easy-to-follow photo details. These details shall include: Detailed unit specific assembly instructions with typical photo's of assembly for both unit and component installation List of tools required for field installation

.5 Panel gasket supplied with the unit shall be a high quality weather resistant closed-cell EPDM sponge rubber. Units relying on field applied caulk for sealing are not acceptable. Units shall be securely assembled using machine bolts. Units relying on sheet metal binding screws for field assembly are not acceptable.

.6 Units shall be accompanied by detailed bills of material for each pallet and crate, pallet check lists, panel maps, parts, construction information and document check lists. All major components shall be identified to match the bills of material and packing lists.

.7 Casing deflection shall not exceed L/200 at +3.0 kPa in all positive pressure sections and -3.0 kPa in all negative pressure sections where L is defined as the panel span. Panels shall be designed to deflect no more than 1/200 of span under operating design conditions when measured at the panel span. Casing shall be rated for 1% leakage at 1.5 times the operating pressure with a maximum overall pressure of 3.0 kPa.

.8 The unit shall be constructed on a 3.0mm galvanized perimeter rail. Rail height shall be selectable in 25mm increments.

.9 Gasket supplied with the unit shall be a high quality weather resistant closed-cell EPDM sponge rubber. Each section shall include a label to aid in proper field assembly. Floors shall be designed to deflect no more than 1/200 of span under operating conditions.

.10 Floors shall be fabricated of 1.5mm G-90 galvanized steel. All floor sheets shall be isolated from the base assembly with an EPDM thermal break gasket.

.11 Floors shall be insulated with a two-part polyurethane water impervious foam insulation.

.12 Floors shall include a drain outlet routed through the perimeter base.

.13 Wall and roof panels

.1 Panels shall be 50mm thick double wall construction. Panel joints shall be sealed with an industrial EPDM gasket to form a water and airtight seal. Air handling manufacturers using caulk to seal panels must include an owner witnessed field leakage test. The test shall require the unit to be field design air flow tested and cabinet leak tested for 1% at 1.5 times the operating pressure.

.2 Panels shall be individually removable for service without removing the roof or compromising the integrity of the cabinet wall. Panels shall be joined with 8mm bolts that can be removed and refastened. Panel attachment with screws is not acceptable. All panels shall utilize thermal break construction between the exterior panel and the interior liner and between the panels and the base and roof frames.

.3 For long term durability, exterior panels shall be a minimum 0.9mm G90 galvanized steel.

.4 Interior liners shall be perforated, a minimum 0.9mm G90 galvanized steel. Perforated panel liners shall be of a single piece construction and attached to the exterior panels with a full

thermal break. To allow for cleaning, no fasteners shall be used on the exposed liner surface. Single wall units are not acceptable.

.14 Insulation - All wall and roof panels shall be insulated with an injected foam insulation with an RSI value of 1.16 / 25mm. Panels shall be designed to deflect no more than 1/200 of span under operating design conditions when measured at the panel seam. Insulation shall fill the panel without voids. Panels shall have a minimum 0.9mm G90 galvanized steel solid interior liner.

.15 Access doors shall be provided into all sections of the air-handling unit as indicated in the plan documents. Doors shall be sized as shown on plan drawings, shall be a minimum 50mm thick with RSI 2.3 polyurethane foam insulation and shall be double wall construction using the same material type as the corresponding section. Doors shall comply with the requirements of UL 1995 and NFPA 90. The door frame shall be 3.2mm extruded 6063-T5 aluminum. Each door shall be mounted with adjustable die cast aluminum hinges. All doors and mounting frames shall incorporate a thermal break design and the doors shall seal to a replaceable extruded EPDM sponge rubber gasket. Doors shall open against static pressure or shall include a pressure relief feature on the door latch. The door latch assembly shall consist of a roller cam compression arm with a chrome plated steel inner handle and glass fiber/nylon composite outer handle. One tool operated lock shall be provided on each fan section access door. All doors shall have a minimum of two latches.

.16 The entire unit, including walls, roof, doors, joints, and seams shall include thermal break construction. This construction shall be supported by tested performance producing no condensation on the exterior surface when the air tunnel temperature is 10°C DB.

.3 Fan Assemblies – Direct Drive Fan

.1 Fan shall be direct-drive, non-overloading SWSI plenum fans designed for industrial duty and suitable for continuous operation.

.2 Fans shall use one or more welded structural steel assemblies and shall be of the sized specific for this intended operation. Screwed or riveted frames are unacceptable. Fan assemblies shall be attached directly to base structural members.

.3 Fan wheels shall have a minimum of 12 airfoil blades for superior sound characteristics and shall be constructed of aluminum to reduce rotational weight and vibration. Fan blades shall be extruded aluminum for uniformity and improved vibration characteristics.

.4 Fan and motor assembly shall be independently isolated within the structural assembly using 25mm deflection spring isolators. Isolators shall be mounted in a three point arrangement that provides both vertical and horizontal (thrust) isolation and shall not require field adjustment. If hard mounted or rubber in shear is used in place of internal spring isolations, external isolation of the entire unit is required. Isolation system shall be

seismic rated to withstand seismic forces in as required in the Province of BC.

.5 A fan inertia base shall be provided or the fan structure shall exceed an equivalence of 2x mass of the total rotating parts of the fan. Fan and motor assemblies shall be designed such that no natural frequencies exist within the operating RPM range of the fan, eliminating the need for "lockout" frequency settings in the variable speed drive. The purchasing contractor will be responsible for all costs associated with externally isolating any unit that does not include individual fan isolation.

.6 Fans shall meet the minimum motor efficiency, maximum brake horsepower and total motor horsepower values scheduled. All fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed. Manufacturer must ensure maximum fan RPM is below the first critical speed. Fans shall be Class 2 construction.

.7 Fan and motor assemblies shall be dynamically balanced by the manufacturer to a maximum allowable vibration of 1.0mm per second at design RPM and a maximum 2.0mm per second overall vibration limit to bring the fan balance in conformance to a BV-5 Grade G1 per ANSI/AMCA 204. In addition, the manufacturer shall insure that no critical frequencies exist in the fan operating range by varying motor speed in 1Hz increments from design RPM to 50% of design RPM.

.8 Unloading:

.1 Fans shall be provided with unloading technology to allow fan modulation without surge from 100% to 10%; while maintaining the part load static pressure requirements of the system. There shall be no static pressure or intake plenum losses or any horsepower penalty associated with the system.

.2 Fan system shall be a self-contained system independent of the building system temperature controls. No powered actuators or control signals are required. Any control points required to operate the unloading sequence shall be wired by the AHU manufacturer to a single point of control for the building automation system to interface. If control points are required, coordination with the AHU manufacturer on control sequence responsibilities shall be required at time of submittal approval.

.3 Control system shall indicate the fan operating and not operating.

.4 Fan curves shall be submitted; with the system curve indicating the minimum system operating static pressure and the point of fan surge.

.4 Motors

.1 Electrical characteristics and horsepower shall be as specified on the project schedule.

.2 Motors shall be Premium Efficiency per NEMA MG1 Table 12-12 TEFC type, shall have NEMA Class F insulation, shall meet NEMA Standard MD-1

Inverter Duty rating and shall be designed to withstand 1600V peak voltage spikes and rise times ≥0.1 microseconds.

.3 Motors shall have grease lubricated ball bearings designed to deliver a minimum L10 life of 250,000 hours at full load and the maximum operating RPM of the associated fan. Grease zerks and spring loaded grease relief valves shall be provided in each motor to allow easy bearing lubrication without damaging the seals due to over lubrication.

.4 For efficient operation in a direct drive application, motors shall be capable of operating greater than 60HZ to at least the design operating speed of the fan.

.5 Each motor shall be field wired directly to an individual VFD. Provide VFD and field wiring between motor and VFD.

.6 Each motor shall be provided with a shaft grounding device to harmlessly bleed potential induced shaft voltages to ground. Provide grounding test report.

.5 Unit Sound Power

.1 Fan sound power levels (dB) for the unit shall not exceed values as indicated: 63Hz at 81/84 (dB inlet/outlet) and 125Hz at 79/85 (dB inlet/outlet).

.2 Unit manufacturer shall provide certified inlet, supply and casing radiated, sound power levels based on the final unit configuration.

.6 Heating Coils

.1 Provide complete coil section(s) with service access door(s) as shown on the plan drawings. Coil connections shall extend through the section casing for ease of installation. Coil connections must be sealed from both the inside and exterior surfaces of the panel with the sleeve of the inner seal covering the pipe within the depth of the panel, all to minimize leakage and condensation. An integral galvanized steel air seal which completely seals around the coil casing and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 1.5mm materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches.

.2 Multiple, "stacked" coil arrangements must be constructed so as to allow independent removal of any coil without the removal of another within the coil bank.

.3 All coils shall meet or exceed the capacities specified on the mechanical schedule and all water coil performances shall be certified in accordance with the AHRI Forced Circulation Air Heating and Air Cooling Coil certification program which is based on AHRI Standard 410. Face velocities shall not exceed those specified on the mechanical schedule.

.4 Water coils shall be of a staggered tube design with high efficiency die formed corrugated plate-type fins for maximum performance. All coils shall be tested with 2758 kPa compressed air under clear water. Coils shall

be designed to operate at 2069 psig internal pressure and up to 121.1°C. Tubes shall be 16mm diameter, seamless 0.5mm wall copper, mechanically expanded into full drawn fin collars for a continuous compression bond over the full finned length for high efficiency performance. Coil casings shall be a minimum 1.5mm galvanized steel. Coil casing reinforcements shall be required for fin lengths over 1067mm. Coil fins shall be 0.2mm thick copper. Coils shall be serviceable using 6mm M.P.T. drain and vent taps on the supply and return headers. Threaded seamless red brass coil connections shall be brazed to copper supply and return headers.

.7 Filters

.1 Provide complete filter section(s) with filter racks and service access door(s) as shown on the plan drawings. Holding frames provided for medium efficiency applications will be either upstream or downstream accessible. Holding frames provided for high efficiency applications will be upstream accessible, only. Holding frames shall be constructed from heavy gauge galvanized steel and shall be equipped with polyurethane foam gaskets. Frames shall be installed with vertical stiffeners and appropriate frame-to-frame sealant to provide a rigid leak tight assembly. An integral air seal which completely seals around the filter frame assembly and extends to the unit pressure bearing surface shall be provided. Air seals/safing materials that are mechanically fastened to the inner liner of the cabinet only shall be constructed of 1.5mm materials to match the material type in the appropriate section and shall be gasketed and have fasteners every 3 inches

.2 Filter fasteners shall be capable of being installed without the requirement of tools, nuts or bolts. The holding frame shall be designed to accommodate standard size filters with the application of the appropriate type fastener. The filter rack shall be designed to use standard 600x600 and 300x600 filters only. Odd sized filters are not allowed. Holding frame assemblies shall be sized to meet or exceed the face area specified by the mechanical schedule.

.3 Angle filter racks shall be provided. Angle racks shall be fabricated from a minimum 1.5mm galvanized steel. Angle racks shall be applied in medium efficiency filter applications, and will be either upstream or side accessible. Upstream access filter racks shall have one central access cover per row of filters, centered in the unit for easy access. Side access filter racks over 1800mm long shall include an angle center reinforcement support. Filter racks shall be sized to meet or exceed the area specified in the mechanical schedule. The filter rack shall be designed to use standard 600x500 and 300x500 filters only. Odd sized filters are not allowed.

.4 Medium efficiency pleated filters shall be 50mm thick, 30% efficient MERV 8 as rated by ASHRAE Standard 52.1 test methods. Filter media shall be of the non woven cotton fabric type. The filter shall have an average efficiency of 30%. Filters shall be UL900 Class 1 listed

.8 Gauges

.1 A Magnehelic differential pressure gauge shall be provided factory installed for measuring the pressure drop across each filter bank. The gauge shall be a diaphragm actuated dial type, 121mm O.D., with white dial, black figures and graduations and pointer zero adjustment.

.2 An inclined differential pressure gauge shall be provided factory installed for measuring the pressure drop across each filter bank. The gauge shall be liquid filled inclined type with black figures, graduations and pointer zero adjustment.

.3 BMS interfacing capability.

.9 Control Dampers – duct mounted externally.

.10 Electrical Power and Controls

.1 Unit operating voltage shall be 208V, 3 phase, 60Hz. All wiring and electrical equipment supplied by the manufacturer shall conform to and be installed in accordance with the requirements of UL1995.

.2 Provide copper wires, bus bars, and fittings throughout, except internal wire of the control transformer may be aluminum if copper termination is provided. Identify power supply terminals with permanent markers. The maximum temperature of terminals shall not exceed 75°C when the equipment is tested in accordance with its rating. Wiring shall be run in plated EMT rigid conduit.

.3 Mount a permanent nameplate on the unit to display the manufacturer, serial number and model number, date of manufacture, horsepower, current rating and voltage.

.4 Furnish and install a NEMA 1 non-fused disconnect switch for the supply fan. Disconnect switch to be mounted on the exterior of the unit housing.

.5 The AHU manufacturer shall mount all damper actuators in coordination with the controls contractor. Control wiring to the actuators shall be brought to a panel and terminated at a terminal strip for field connection. Actuators for modulating service shall be direct coupled, electronic type. Actuators for outside air and exhaust air control shall be automatic return type.

.6 The controls contractor shall provide all other necessary controls and damper actuators to achieve the sequence of operation as specified in Section 23 09 93 – Control Sequences of Operation.

.7 Provide and field install an ECM control panel and a control panel transformer (shipped loose). Connect 3-phase power plus ground between the control transformer and to the ECM control panel, then from the ECM control panel to the fan motors.

.11 Capacity

.1 As indicated on drawing equipment schedules.

.12 Unit Testing and Quality Control

.1 The fans shall be factory run tested to insure design integrity and proper RPM. All electrical circuits shall be tested to ensure correct operation before shipment of unit. All direct drive fans shall be dynamically balanced as a complete assembly. Maximum vibration level shall be 2.0mm/second peak velocity, filter-in readings taken with the filter tuned to the RPM of the fan. Units shall pass all quality control checks and be thoroughly cleaned prior to shipment.

.2 All units' cabinets shall be field tested following job site installation to verify its cabinet leakage rating at design positive operating static pressure. Cabinet leakage shall not exceed a Leakage Class rating of 5 as defined by ANSI/ASHRAE Standard 111. With all unit openings sealed, air shall be pumped into (or out of) the unit until the appropriate cabinet operating pressure is achieved. Once design pressure has been achieved, the volume of air needed to maintain the cabinet design pressure shall be measured in compliance with AMCA Standard 210. Testing shall be performed by the installing contractor under supervision by a direct employee of the AHU manufacturer or by a manufacturer certified technician. The testing shall be witnessed by the departmental representative. A detailed report, including all data and test methods, shall be presented to the departmental representative prior to equipment shipment.

.13 Warranty

.1 The complete unit shall be covered by a full warranty covering the first year of operation.

.2 All rotating parts shall be warranted by the unit manufacturer for a full five (5) years from date of unit start-up.

2.2

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install as per manufacturers' instructions for mounting on concrete roof curbs and as indicated.

.2 Manufacturer representative to certify installation, supervise start-up and commission unit. Provide written report and written certification for review and record.

.3 Pipe drain in unit service to storm system.

.4 Install in strict accordance with manufacturer's requirements, shop drawings, and Contract Documents.

.5 Equipment assembly to be supervised by a direct employee of the AHU manufacturer or by a manufacturer certified service organization. Provide supervision for as long a period of time as is necessary to ensure proper assembly or onsite training.

.6 Adjust in alignment on concrete floor, sole plates or other supporting structure. Bolt, level, grout to floor and gasket frame.

.7 Install components and panels.

.8 Coordinate in advance of equipment arrival the electrical installation with electrical contractor.

.9 Coordinate in advance of equipment arrival the controls with control contractor.

.10 Coordinate, in advance of scheduled assembly, the verification, marshalling and readiness of all unit components.

.11 Provide all appurtenances required ensuring a fully operational and functional system.

.12 Start-Up

.1 Equipment start-up is to be supervised by the unit manufacturer or a manufacturer-certified service organization. Physical connections and start-up are provided by the installing contractor. The start-up engineer shall conduct such operating tests as required to ensure that the unit is operating in accordance with design. Complete testing of all safety and emergency control devices shall be made. The start-up engineer shall submit a written report to the owner and manufacturer containing all test data recorded as required above and a letter certifying that the unit is operating properly.

.2 Provide complete Operation & Maintenance Manuals with descriptive literature, model, and serial number of all equipment, performance data, manufacturer's instructions for operating and maintenance, lubrication recommendation and schedule, and winter shutdown procedure.

.13 Installation shall comply with vibration and seismic requirements as detailed in Sections 23 05 48 and 23 05 49.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its product[s], and submit written reports, in acceptable format, to verify compliance of work with Contract.

.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 at stages listed:

.1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.

.2 During installation, when components are joined, sealed, and/or connected.

.3 During startup and testing.

.4 Upon completion of work, after cleaning is carried out.

.2 Obtain reports within 3 days of review and submit immediately to Departmental Representative.

.3 Performance Verification:

.1 Air Handling Units:

.1 Set outside air and return air dampers for minimum outside air.

.2 Check for smooth, vibration less correct rotation of supply fan impeller.

.3 Measure supply fan capacity.

.4 Adjust motors, belts, drives, and VFD as necessary and repeat measurement of fan capacity.

.5 Measure pressure drop of each component of air handling unit.

.6 Set outside air and return air dampers for the % of outside air required by design and repeat measurements of fan capacity.

.7 Reduce differences between fan capacity at minimum and maximum outside air less than 5%.

.8 O/A damper: verify for proper stroking, interlock with R/A damper.

.9 Measure DBT, WBT of S/A, R/A, O/A.

.10 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air, O/A.

.11 Use smoke test to verify no air leakage and infiltration around unit.

.12 Simulate maximum heating load and:

.1 Verify temperature rise across heat exchanger.

.2 Simulate minimum heating load and repeat measurements.

.13 Verify operating control strategies, including:

.1 Heat exchanger operating and high limit.

.2 Early morning warm-up cycle.

.3 Freeze protection.

.4 Economizer cycle operation, temperature of change-over.

.5 Alarms.

.6 Voltage drop across thermostat wiring.

.7 Operation of remote panel including pilot lights, failure modes.

.14 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than 5%.

.15 Check capacity of heating unit.

.16 Refer to other sections of these specifications for PV procedures for other components.

.2 Start-Up:

.1 General: in accordance with manufacturer recommendations.

.3 Verify accessibility, serviceability of components including motorized dampers, filters, coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.

.4 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.

.4 Commissioning Reports:

.1 In accordance with Section 23 08 00 – Mechanical Commissioning.

3.4 DEMONSTRATION

.1 Training: In accordance with the requirements in Section 01 91 41 – Demonstration and Training.

.2 Submittals: In accordance with the requirements in Section 00 01 50 – General Instructions (CSC).

3.5 CLEANING

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 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 & 28 in the Master Format or the Canadian Master Specifications.

.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 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 Owner. 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 Owner's Commissioning Authority. 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 (current adopted edition) - 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 NBCC 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.

.6 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 Section 00 01 50 General Instructions (CSC).

.2 Product Data: submit WHMIS MSDS in accordance with Division 01 Requirements and Division 02- Hazardous Materials

.3 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 metric 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.

.4 Format

.1 PDF submitted via e-mail.

.2 Bill of Quantities for related components, identified by model number, listed on the front cover with item identification numbers.

.5 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 Representative.

.6 Keep one (1) copy of shop drawings and product data, on site, available for reference.

.7 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.

.8 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.

1.6 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Division 01 - 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 Division 01 - Construction Progress Schedule

.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 Division 01 - Health and Safety Requirements.

1.7 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 Division 01 Construction/Demolition Waste Management and Disposal.

1.8 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 engineer 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.

1.9 OPERATING INSTRUCTIONS

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.3 Safety precautions.

.4 Procedures to be followed in event of equipment failure.

.5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

1.10 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Division 01 - Construction/Demolition Waste Management and Disposal and with the Waste Reduction Work plan.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

1.11 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 project 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.

1.12 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 Owner, 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.

1.13 SPRINKLER PROOF REQUIREMENTS

.1 All equipment and wiring systems shall be sprinklerproof 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.

1.14 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.

1.15 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.

1.16 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.

1.17 BUILDING OPERATION DURING CONSTRUCTION

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

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

1.18 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 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, 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. 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 Physical Plant and will normally be scheduled to occur during evenings or weekends. The Owner 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.

1.19 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.

1.20 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.

1.21 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 considered valid or 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.

1.22 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.

1.23 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 pullboxes 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.

1.24 PROGRESS CLAIM AND CHANGEORDER BREAKDOWNS

.1 Submit price breakdowns ten (10) days after the award of contract,

.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 $10,000.00.

.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.

1.25 PROJECT CLOSE-OUT REQUIREMENTS

.1 Refer to detailed specifications in each section for detailed requirements.

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.

1.26 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.

.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 owner have been completed.

.3 Departmental Representative's 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.

.3 Provincial or City Electrical Inspection - Certificate of inspection.

.4 Seismic Engineer's letter of Assurance and final inspection report (As required).

.5 Certificate of Substantial Performance.

.6 Signed off copy of Departmental Representative's final inspection report.

.7 Fire alarm verification.

1.27 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 and 28 (electrical) work have been met and verified.

Part 2 Products

2.1 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.

2.2 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.

2.3 WIRING TERMINATIONS

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

2.4 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 – Panel/CDP designation – Size 4 lettering

.2 Line 2 – eg 225A, 120/208V, 3 phase 4W – Size 2 lettering

.3 Line 3 – Feeder: eg 4#3 – 35mm C – Size 2 lettering

.4 Line 4 – Origin eg: Main Elect. Room – Size 2 lettering

.2 Distribution Circuit Breakers – 4 lines

.1 Line 1 – Main Circuit Breaker – Size 4 lettering

.2 Line 2 – Feeder: eg 4#3 – Size 2 lettering

.3 Line 3 – 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.

.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 numbers 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.

2.5 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.

2.6 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

SYSTEM	MAJOR BAND	MINOR BAND	CHARACTERS
347/600V Normal	Dark Blue		
120/208V Normal	Light Blue		
Ground	Dark Green		GR
Fire Alarm	Red		FA
Emg Voice Paging	Red	Dark Green	EP
Computer/Data	Light Green		COM
Telephone	Light Green	Black	TEL
General Intercom	Light Green	Yellow	IC
Low Level Paging	Light Green	White	PA
Building Alarm	Purple	White	BA
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

2.7 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.

.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.

2.8 ANCHOR BOLTS AND TEMPLATES

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

2.9 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 or Hilti Channel, or equivalent.

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

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

.2 Drilled, mechanical expansion type:

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

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

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

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

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

.3 Drilled, adhesive type:

.1 Hilti HVA or UCAN, or equivalent Adhesive Anchor 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.

2.10 EQUIPMENT SUPPORTS

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

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

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

2.11 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 primed and undercoat painted ready for finish under the related Division.

2.12 MAINTENANCE MATERIALS AND CABINET

.1 Provide maintenance materials in accordance with Division 01 and specified in appropriate Sections.

2.13 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.

.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 thirty (30) days prior to start up of the systems and equipment.

.6 Submit three (3) copies in the final approved form.

2.14 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" CAD files will be provided by the Departmental Representative. The Electrical Division shall include all associated costs to obtain and complete the CAD Record Drawings including retaining the services of an approved 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 "Record Drawing" CAD files and one set of plots to the Departmental Representative prior to Total Performance of the contract.

.5 Note: The Contractor will be required to sign a standard Stantec / 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 cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to a minimum.

.2 Install roof jacks where conduit and cables penetrate roofs. Apply sealant after installation.

.3 All cables and conduits to be installed concealed in finished areas.

3.4 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.

3.5 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 voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.2 Conduct and pay for the following tests:

.1 Circuits originating from branch distribution panels.

.2 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.3 Systems: fire alarm system for all affected devices.

.4 Main ground resistance (at all grounding locations).

.5 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.4 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.

.5 Reports:

.1 Provide written reports in a timely manner upon completion of the testing and load balance. Indicate test hour and date.

3.6 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 prime contractor.

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 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 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.

.3 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.

.4 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.

.5 Provide fire stopping material and system information in the maintenance manuals and via labels at major penetrations that are likely to be repenetrated.

.6 Allow openings for 100% capacity of raceway or 200% capacity of J-hooks.

.7 Provide split systems where existing cables are involved.

.8 Provide Firestopping approval certificate in including a Building Code / By-Law Schedule B-1, B-2 & C-B signed by a BC registered Professional Engineer. Submit a letter certifying that all work is complete and in accordance with this specification.

.9 Allow for 5% destructive testing of installed firestopping assemblies under this contract.

3.12 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.

3.13 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.

3.14 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.

3.15 EQUIPMENT INSTALLATION

.1 Provide means of access for servicing equipment.

.2 CSA identification and equipment labels to be clearly visible after installation.

3.16 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 Engineer.

.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 shall be provided by other Divisions, coordinated and supervised by the Electrical Divisions.

.9 Excavation and backfilling will be provided by other Divisions. This Division to superintend the work and provide all layouts and parameters.

3.17 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 prime contractor.

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 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 00 01 50 General Instructions (CSC).

.2 Do verification requirements in accordance with Division 01 Sustainable Requirements: Contractor's Verification.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.

.2 Avoid using landfill waste disposal procedures when recycling facilities are available.

.3 Place materials defined as hazardous or toxic waste in designated containers.

1.4 PCB (POLYCHLORINATED BIPHENYLS)

.1 Carefully remove any electrical items containing PCB's (eg light fixture ballasts) from equipment or fixtures to be renovated or demolished. Removed items (containing PCB's) to be catalogued and stored on site in approved labelled storage containers in accordance with regulations.

1.5 SCOPE

.1 The Electrical Division to take note that the demolition and renovation will be done in an occupied building that is normally occupied during the day. Maintain electrical and communication systems as required to minimize services disruption.

.2 The Electrical Division to also take note of the dust containment requirements as outlined in the architectural and front end specification.

.3 Electrical tender documents do not show all existing luminaires, wiring devices, conduit, boxes or wire. Conduit routing and wire grouping is not known. During demolition, the Electrical trade(s) are to deactivate all existing electrical and communication systems affected in such a manner that complete systems are not deactivated and system circuits affected in party wall partitions to be reactivated immediately on a temporary or permanent basis as site conditions dictate.

.4 Any discrepancies appearing on the drawings or in this specification are to be brought to the attention of the Departmental Representative who will provide instruction.

.5 Where devices are not shown on the new plans in walls that are not being removed, such devices are to be reinstated and remain.

Part 2 Products

2.1 STANDARDS

.1 Refer to applicable material standards in other specification sections and/or as detailed on drawings.

Part 3 EXECUTION

3.1 DEMOLITION

.1 Demolition to be carried out in strict conformance to provincial, local and municipal authorities and Part 8 of the B.C. Building Code current edition.

.2 All redundant electrical components in the areas of demolition excluding those specifically identified in the following clauses shall become the property of the Electrical Division and shall be removed from site.

3.2 DISRUPTION TO OPERATIONS

.1 Contractor to issue a scheduled shutdown time and coordinate installation of the new equipment as appropriate. All equipment installed and modified requires testing before start-up.

.2 Contractor to provide temporary connections to all required equipment for temporary power during the installation of any new equipment.

3.3 REUSE OF EXISTING COMPONENTS

.1 Existing components may be reused only where so specifically indicated on the drawings or in the specifications, however in all cases all wiring shall be new and no splicing shall be permitted at any location.

3.4 DISTRIBUTION OF CIRCUITS

.1 Circuit: power, voice/data, fire alarm, control etc. which are disrupted during demolition and are essential, to be made good immediately. The Electrical Trade(s) to identify these circuits to the Departmental Representative. Specific tasks involving the demolition of essential circuits will require that the contractor to obtain permission from the Owner before proceeding.

3.5 ABANDONED CONDUIT, WIRE AND EXISTING CIRCUITS

.1 All abandoned conduit and wire to be removed and disposed of by the Electrical Divisions.

.2 Remove all accessible (eg. Surface) wiring and cables back to source.

.3 Remove abandoned outlets and raceway, even if in or behind drywall, where they are located behind millwork or in locations unsuitable for reuse i.e. not at standard heights for switches or outlets.

.4 All remaining circuits to be rerouted as required and suitably secured to the building structure.

.5 Any cabling, including voice/data wiring, presently resting on any suspended ceiling system to be removed as part of the renovation process and shall be neatly bundled, protected and permanently secured to building structure. No cabling is permitted to rest on the ceiling system.

3.6 EXCAVATION AND CUTTING DAMAGE

.1 Circuits disrupted by floor cutting or drilling (ie. buried cables) to be brought to the attention of the Departmental Representative. Obvious systems disturbed because due care and attention was not followed, shall be repaired immediately at no additional cost to owner.

3.7 FIRE ALARM SYSTEM

.1 Construction/demolition activities in existing building may require that certain fire alarm devices are protected from construction dust, damage etc. Coordinate with the Departmental Representative as required to protect components of the fire alarm system to prevent nuisance operation and alarms.

.2 Provide, install and test temporary heat detectors in the area of construction where the construction area is not protected by an active supervised fire protection sprinkler system. The "construction" detectors to be removed and discarded at the end of the project.

.3 Provide temporary replacement of smoke detectors with heat detectors including interim programming and testing and final re-verification to minimize false alarms and to ensure other occupants of the building are protected.

.4 Maintain existing fire alarm system in areas under construction where practical. Relocate, rewire and provide interim connections as required while installing the new system to replace the existing. Provide temporary fire alarm devices and audible signals to suit any temporary Existing provisions.

.5 Contractor to check in with the Departmental Representative at the start and end of each working day to confirm the fire alarm status in the area of work. Arrange for the related fire alarm zone card or area to be deactivated either to suit the progress of the work and/or where dust will be present on a day to day basis. Bag and protect fire detectors in dusty areas during construction. Remove

any bagging at the end of the work day. Any existing detectors subject to construction dust to be immediately vacuumed and marked to be replaced at the end of the project. Any fire alarm devices subject to moisture to be replaced immediately.

.6 The fire alarm system is to be fully functional in the area of construction when the contractor is neither on site nor after the contractors normal work hours. (ie overnight, holidays, weekends)

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

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

.2 Section 26 05 32 - Conduit, Tray, Wireway, Boxes, and Fittings

.3 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 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.2 No. 131, Type Teck 90 Cable

.2 CAN/CSA C22.2 No.65, Wire Connectors

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

.1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

Part 2 Products

2.1 PRODUCT DATA

.1 Submit product data in accordance with Section 00 01 50 General Instructions.

2.2 BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Jacketed.

.3 Underground installations: RWU90XLPE, size as indicated.

2.3 WIRES FOR MOTORS CONTROLLED BY PULSE WIDTH MODULATED SIGNALS

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Jacketed.

.3 Classified as VFD rated cable.

2.4 TECK 90 CABLE

.1 Teck 90 cable only permitted to connect to equipment susceptible to vibrations.

.2 Cable:

.1 To CAN/CSA-C22.2 No.131 Type Teck 90 Cable.

.2 In accordance with Section 26 05 00 - Common Work Results for Electrical.

.3 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.4 Insulation:

.1 Cross-linked polyethylene XLPE.

.2 Rating: 1000 V.

.5 Inner jacket: polyvinyl chloride material.

.6 Armour: interlocking.

.7 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.

.8 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables at 1000 mm centers.

.3 Threaded rods: 6 mm diameter to support suspended channels.

.9 Connectors:

.1 Watertight approved for TECK cable.

.10 Flame-spread rating: FT4

2.5 ARMOURED CABLES

.1 Flexible armoured cabling (BX) shall not be used for the general wiring system other than final drops to recessed light fixtures in concealed locations, where approved by Departmental Representative.

.2 Conductors: insulated, copper, size as indicated.

.3 Type: AC90.

.4 Armour: interlocking type fabricated from aluminum strip.

.5 Type: ACWU90 PVC flame retardant jacket over thermoplastic armour and compliant to applicable Building Code classification for this project in wet locations.

.6 Connectors: anti short connectors.

2.6 CONTROL CABLES

.1 Type: LVT: 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).

Part 3 Execution

3.1 FIELD QUALITY CONTROL

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

.2 Perform tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

.1 Cables only permitted for applications as noted above.

.2 Cables to be run parallel to other cables and conduit, supported by uni-strut at intervals as stated above.

.3 Terminate cables according to code.

.4 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.

.5 Conductor length for parallel feeders to be identical.

.6 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.7 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

.8 All grounding conductors and straps to be copper. All bonding conductors to have green insulation jacket.

.9 Colour coding to be strictly in accordance with Section 26 05 00.

.10 Provide sleeves where cables enter or exit cast concrete or masonry.

.11 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.

.12 Allow nominal 900mm [3'] extra cable looped and supported in the ceiling space to permit fixture relocations of one tile space.

.13 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.

3.3 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 32 - Conduit, Tray, Wireway, Boxes, and Fittings.

.2 In wireways and auxiliary gutters in accordance with Section 26 05 32 - Conduit, Tray, Wireway, Boxes, and Fittings.

3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)

.1 Group cables wherever possible on channels.

.2 Install cable securely supported by straps and/or hangers.

3.5 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible on channels.

.2 Install cable securely supported by straps and/or hangers.

3.6 INSTALLATION OF CONTROL CABLES

.1 Install control cables in conduit.

.2 Ground control cable shield.

3.7 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.

3.8 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 Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.

.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.

.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.

.2 Provide grounding for all dust collector ductwork.

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 System and circuit, equipment, grounding conductors, bare stranded copper, soft annealed, sized as indicated. Insulation where specified or required to be green.

2.3 INSTALLATION GENERAL

.1 Expand existing complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories to suit new equipment.

.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 Use mechanical connectors for grounding connections to equipment provided with lugs.

.6 Soldered joints not permitted.

.7 Install bonding wire for flexible conduit, connected at both 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.

.8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.10 Bond single conductor, metallic armoured cables to cabinet at supply end and provide non-metallic entry plate at load end.

.11 Provide a bonding conductor appropriately sized within each raceway routed within the building.

.12 All bonding and grounding connections to be compression type unless noted otherwise.

.13 Expand existing system as required to provide complete grounding and bonding system as indicated and as required by Canadian Electrical Code and the local electrical inspection authorities.

.14 All components shall be securely and adequately bonded and where required to accomplish this, bonding jumpers, grounding studs and bushings shall be used.

.15 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.

.16 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.

.17 Bond all low tension equipment with #6 AWG bonding conductor.

.18 All metallic conduits longer than 1m in length, containing a single grounding or bonding conductor, shall be bonded as per the Canadian Electrical Code.

2.4 EQUIPMENT GROUNDING OR BONDING

.1 Install grounding or bonding connections to typical equipment included in, but not necessarily limited to following list: duct systems, frames of motors, starters, control panels, building steel work, and distribution panels.

2.5 MECHANICAL EQUIPMENT GROUNDING

.1 Bond frames of all mechanical equipment

.2 Provide a #6 ground conductor from the mechanical room ground bus to each VFD/VSD.

.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.

2.6 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 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.

.4 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 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Division 01 – Construction / Demolition Waste Management and Disposal and with the Waste Reduction Workplan.

.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 wiremold 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, set screw type. Cast fittings and couplings are not acceptable. Provide plastic bushings (insulated throat) for all connectors. 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 equal.

.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 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.

2.7 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; or equivalent.

.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.

2.8 CONCRETE BOXES

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

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 Conceal conduits in finished spaces unless noted otherwise.

.4 Any conduit exposed in finished areas to be free of unnecessary labels and trademarks.

.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 and communication/data conduits to be minimum 21mm [3/4"] diameter unless otherwise indicated.

.13 All homerun conduits to be minimum 27mm [1"] diameter unless noted otherwise.

.14 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.

.15 Conduits are not permitted in terrazzo or concrete toppings.

.16 Cap turned up conduits to prevent the entrance of dirt of moisture during construction.

.17 Locate conduits more than 75mm [3"] parallel to steam or hot water lines with a minimum of 25mm [1"] at crossovers.

.18 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.

.19 Provide polypropylene pull cord in empty conduits to facilitate pulling wiring in future.

.20 Where conduits become blocked, the use of corrosive agents is prohibited. Remove and replace blocked section.

.21 Damaged conduits to be repaired or replaced.

.22 Dry conduits out thoroughly before installing wiring. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.23 Conduits shall not pass through structural members except as indicated.

.24 Conduit sizes indicated on drawings are minimum only. Increase sizes as required to suit alternative wiring types or to comply with Code.

.25 Conduits and ducts crossing building expansion joints shall have approved conduit expansion fittings to suit the type of conduit used.

.26 Seal conduits with approved sealant where conduits are run between heated and unheated areas.

.27 Seal openings with approved sealant where conduits, cables, or cable trays pierce fire separations in accordance with cUL or ULC approved firestopping assemblies.

.28 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.

.29 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels, or equivalent.

.30 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of standard boxes where box support is not provided.

.31 Provide necessary roof jacks or flashing where conduits pass through roof or watertight membranes. Apply approved sealant to maintain membrane integrity.

.32 Use liquid tight flexible metal conduit for connection to motors, and other vibrating equipment and transformers.

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 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.

3.4 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 6mm [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 REFERENCES

.1 CSA International

.1 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with 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 circuit breakers indoors and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect circuit breakers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers: to CSA C22.2 No. 5

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.5 Circuit breakers to have minimum 10,000A symmetrical rms interrupting capacity rating.

2.2 THERMAL MAGNETIC BREAKERS

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

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 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 Division 01 – Construction / Demolition 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 REGULATORY REQUIREMENTS

.1 The fire alarm system devices are to be installed in accordance with the current editions of the following standards:

.1 C.S.A. Standard C22.1, Canadian Electrical Code, Part 1 (current edition) and bulletins & amendments for British Columbia

.2 The National Building Code (current edition).

.3 CAN/ULC S524: Standard for Installation of Fire Alarm System.

.4 CAN/ULC S537: Standard for Verification of Fire Alarm System.

.2 Installation subject to approval of Departmental Representative and fire marshal for final acceptance.

1.4 SYSTEM

.1 The fire alarm system is existing and will remain. The scope of this project is limited to the removal and reinstallation of one existing duct smoke detector to be installed in the dedicated air handling units. The scope of work to include testing, demonstration, and verification to the satisfaction of the Departmental Representative.

.2 Equipment to be ULC approved.

1.5 TESTS AND ADJUSTMENTS

.1 Upon completion of system installation, tests to be conducted by the system installer to determine system conformity to requirements of the specification. Tests to be conducted in presence of the Departmental Representative who may suspend or discontinue tests at any time performance is considered unsatisfactory. Resumption of testing to cover the previously untested elements

and any completed elements at the discretion of the Departmental Representative.

.2 All equipment or wiring provided by system installer which tests prove to be defective or operating improperly to be corrected or replaced promptly at no additional cost to the Owner.

1.6 LABELLING – DEVICES AND PULLBOXES

.1 Provide a 'Brother' style commercial quality label on each fire alarm device. Label to be clearly visible from the ground and contain the address information to correspond to the walk test voice or page.

Part 2 Products

2.1 GENERAL

.1 DUCT SMOKE DETECTORS

.1 Duct smoke detectors are existing to be removed to allow for modifications to the air handling system, and then reinstalled and re-verified as required.

.2 Ensure installation of duct smoke detector is in accordance with CAN/ULC s524.

.3 Activation of duct detectors to cause shutdown of associated air handling unit, annunciation at control panel and sounding of building alert signal.

Part 3 Execution

3.1 INSTALLATION

.1 System installation shall conform to the latest CAN/ULC-S524 Standard for the Installation of Fire Alarm Systems.

3.2 AUTOMATIC DETECTORS

.1 Coordinate with other trades before proceeding.

.2 Mount detectors out of line of direct heat and minimum 3m [10'-0"] from unit heaters.

.3 Install duct smoke detectors on the supply air side of air handling units. Exact location of duct detectors to be coordinated with Division 23 and fire alarm system manufacturer.

.4 Provide auxiliary contact to shut down air handling unit upon activation of duct smoke detector.

3.3 WIRING

.1 Make conductor terminations on fixed terminal strips with separate terminal for each conductor. No loose wiring connections allowed.

.2 Fire alarm wiring splices to be minimal. Line splices are not acceptable.

.3 Neatly install wiring clamped with nylon cable straps or laced with jute cord.

.4 Number and identify all wiring terminations and terminal strips as indicated on shop drawings.

.5 Attach wiring diagram to inside of panel doors.

.6 All cables crossing fire zones to be protected by 1-hour fire rating.

.7 Coordinate duct detector location and accessibility with mechanical. Provide remote LED's for locations not readily viewable by maintenance personnel.

.8 All backboxes in exposed installations to be as provided by system manufacturer.

3.4 PROTECTION OF COMPLETED WORK

.1 Protect equipment in areas of construction to prevent the entry of dust, paint and any other foreign matter into the devices or panels.

3.5 SYSTEM INSPECTION

.1 Carry out a complete inspection and test of system on completion of the installation to ensure the following:

.1 System is complete and functional in accordance with the contract documents and regulatory requirements.

.2 System is installed in accordance with the manufacturer's recommendations.

.3 Fire suppression detection devices are connected into the system and are functioning.

.4 All auxiliary equipment has been connected and functioning.

.5 On completion of inspection deliver four (4) final sets of maintenance and operating instructions manuals to the Departmental Representative.

3.6 PERFORMANCE VERIFICATION

.1 The Electrical Division Contractor shall be responsible for directing performance verification of the fire alarm system in accordance with the latest CAN-S537, Standard for Verification of Fire Alarm System Installations.

.2 Provide interim partial verifications to suit the progress of the work and any staged occupancy. All work to be tested and verified directly following the installation.

.3 Submit all verification reports to the Departmental Representative. Provide an unconditional Appendix C and written test reports from the equipment manufacturer showing that the complete system has been tested, verified and commissioned by him/her and that the Fire Alarm system complies with all points of the specifications. Include the verification worksheets identifying every device and its status (i.e. "duct smoke detector, RTU-15A - room xx, verified for operation and supervision").

.4 The qualified Fire Alarm verification agency shall be independent of the installing company.

.5 Prior to requesting the final performance verification, ensure that fire alarm system is fully operable and that subsequent work to be performed on system will not invalidate examinations and tests performed during verification procedure.

.6 Include all costs for fire alarm system verifications, including the Fire Alarm System Manufacturer's representative's costs. Take into account that the system may have to be commissioned and verified after normal working hours.

.7 Provide a minimum of ten workings days' written notice ahead of the verification process to the Departmental Representative.

.8 Activate alarms and demonstrate all controls as requested.

END OF SECTION

Appendix

ARCADIS Design & Consultancy for natural and built assets

Public Works and Government Services Canada

Hazardous Materials Assessment for the Matsqui Institution Building M3 Living Unit/Penthouse Mechanical Room

33344 King Road, Abottsford, British Columbia

December 8, 2016

702358-023

Kelly Smith, B.Sc.

Senior Project Manager

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HAZARDOUS MATERIALS ASSESSMENT FOR THE MATSQUI INSTITUTION BUILDING M3 LIVING UNIT/PENTHOUSE MECHANICAL ROOM, 33344 KING ROAD, ABOTTSFORD, BRITISH COLUMBIA

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Date:

December 8, 2016

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1 INTRODUCTION

Arcadis Canada Inc. (Arcadis) was retained by Public Works and Government Services Canada (PWGSC) Pacific Region, on behalf of Correctional Service Canada (CSC), to conduct a hazardous materials assessment in designated areas of the Matsqui Medium Institution Building M3, Living Unit/Mechanical Penthouse Room, located at 33344 King Road, Abbottsford, British Columbia.

It is our understanding that the project includes replacement of four air handling units (AHU) and associated heating pipes servicing the area.

Floor plans of the Building M3 Living Unit/Penthouse Mechanical Room Office are provided in Appendix A.

The survey was undertaken to report on the presence or suspected presence of readily observable hazardous materials.

1.1 Scope of Work

The scope of work for our investigation included:

- review of existing information provided by PWGSC;
- conducting a hazardous building materials assessment of the Building M3 study area (including but not limited to assessment of asbestos-containing materials, lead, silica, mercury, PCB-containing equipment, rodent droppings and mould);
- obtaining representative bulk samples of materials which could contain asbestos, and paint chip samples;
- laboratory analyses of bulk samples for asbestos content and analysis of paint chip samples for lead content; and
- preparation of a report outlining the findings of the investigation.

Mr. Kenny Luong visited the site on November 9 and 10, 2016 to conduct the hazardous materials survey.

2 BACKGROUND INFORMATION ON HAZARDOUS MATERIALS

Canada Labour Code

Requirements related to disclosing the presence of hazardous substances (including designated substances) in federal government buildings are specified in Part II of the Canada Labour Code, sections 124(1)y and 125(1)Z.14, which state that employers shall:

- "ensure that the activities of every person granted access to the work place do not endanger the health and safety of employees [Section y]; and
- take all reasonable care to ensure that all of the persons granted access to the workplace, other than the employer's employees, are informed of every known or foreseeable health or safety hazard to which they are likely to be exposed in the workplace. [Section Z.14]".

When construction or redevelopment work is undertaken by a company whose primary activity is construction or redevelopment work at the site of a federally-regulated employer, the provincial health and safety laws apply. The British Columbia Workers Compensation Act and Occupational Health and Safety Regulations (B.C. Reg. 296/97) would therefore apply to any construction work undertaken at the subject site.

2.1 Asbestos

Asbestos has been widely used in buildings, both in friable applications (materials which can be crumbled, pulverized or powdered by hand pressure, when dry) such as pipe and tank insulation, sprayed-on fireproofing and acoustic texture material and in non-friable manufactured products such as floor tile, gaskets, cement board and so on. The use of asbestos in friable applications was curtailed around the mid-1970s. The use of asbestos in certain non-friable materials continued beyond the mid-1970s.

Control of exposure to asbestos is governed in British Columbia by B.C. Reg. 296/97 – Occupational Health and Safety Regulations. The WorkSafe BC publication *Safe Work Practices for Handling Asbestos* provides additional guidance.

B.C. Reg. 296/97 states that "asbestos-containing material" means the following:

(a) a manufactured article or other material, other than vermiculite insulation, that would be determined to contain at least 0.5% asbestos if tested in accordance with one of the prescribed methods.

(b) vermiculite insulation that would be determined to contain any asbestos if tested in accordance with the prescribed EPA method.

B.C. Reg. 296/97 prescribes certain requirements for asbestos management in buildings.

For on-going asbestos management in buildings, employers are required to:

- develop and implement an exposure control plan if a worker is or may be exposed to potentially harmful levels of asbestos;
- prepare an inventory (i.e., asbestos survey report) of all asbestos-containing materials in the workplace; keep the inventory at the workplace and keep the inventory current;
- ensure that a risk assessment is conducted by qualified person on asbestos-containing material identified in the inventory, with due regard for the condition of the material, its' friability, accessibility and likelihood of damage, and the potential for fibre release and exposure of workers;
- ensure that before a work activity that involves working with or in proximity to asbestos-containing material begins, the work activity is assessed by a qualified person and classified as a low, moderate or high risk activity;
- ensure that all friable asbestos-containing materials in the workplace are controlled by removal, enclosure or encapsulation so as to prevent the release of airborne asbestos fibre;
- prohibit any work that would disturb asbestos-containing material unless necessary precautions have been taken to protect workers;
- ensure that procedures for handling or using asbestos-containing material prevent or minimize the release of airborne asbestos fibres;
- ensure that the procedures for control, handling or use of asbestos are in accordance with procedures acceptable to the board;
- provide training for staff who are at risk of exposure to asbestos;

"Waste asbestos" is classified as a "hazardous waste" and is defined in the British Columbia Hazardous Waste Regulation (B.C. Reg. 63/88) as "a waste containing friable asbestos fibres or asbestos dust in a concentration greater than 1% by weight". Section 40, Part 6 of the regulation provides requirements for management of asbestos waste.

2.2 Lead

Lead is a heavy metal that can be found in construction materials such as paints, coatings, mortar, concrete, pipes, solder, packings, sheet metal, caulking, glazed ceramic products and cable splices. Lead has been used historically in exterior and interior paints.

B.C. Reg. 296/97 prescribes specific requirements for control of workplace exposure to lead. Employers are responsible for developing and implementing an exposure control plan if workers are or may be exposed to lead. The WorkSafe BC publication "Lead-Containing Paints and Coatings, Preventing Exposure in the Construction Industry" provides guidance in the measures and procedures that should be followed when handling lead-containing paints and coatings during construction projects and states the following:

- "Information from the U.S. Occupational Safety and Health Administration (OSHA) suggests that the improper removal of lead paint containing 600 mg/kg lead results in airborne lead concentrations that exceed half of the exposure limit. This would trigger the requirement for an Exposure Control Plan (ECP) and safe work procedures.
- Lead concentrations as low as 90 mg/kg may present a risk to pregnant women and children. Any risk assessment should include for the presence of high risk individuals within the workplace."

The *Surface Coating Materials Regulations* made under the *Hazardous Products Act* (SOR/2005-109) sets a maximum concentration of total lead of 90 mg/kg (0.009 percent or 90 parts per million) for surface coating materials, including paints, effective 21 October 2010. This criterion level applies to the sale and importation of new surface coating materials.

In addition, under the *Hazardous Waste Regulation* (B.C. Reg. 63/88, including amendments up to B.C. Reg. 63/2009, April 1, 2009), identified lead-based paints (LBPs) must also undergo Toxicity Characteristic Leachate Properties (TCLP) testing to determine disposal procedures. The acceptable TCLP limit for disposal of LBPs is less than 5 milligrams per litre (mg/L). If an identified LBP exhibits a TCLP result of less than 5 mg/L, the paint is not considered a hazardous material and may be disposed as construction waste.

The National Plumbing Code allowed lead as an acceptable material for pipes until 1975 and in solder until 1986.

2.3 Mercury

Mercury has been used in electrical equipment such as alkaline batteries, fluorescent light bulbs (lamps), high intensity discharge (HID) lights (mercury vapour, high pressure sodium and metal halide), "silent switches" and in instruments such as thermometers, manometers and barometers, pressure gauges, float and level switches and flow meters. Mercury-containing lamps, the bulk of which are 1.22 m (four foot) fluorescent lamps contain between 7 and 40 mg of mercury each. Mercury compounds have also been used historically as additives in latex paint to protect the paint from mildew and bacteria during production and storage.

The intentional addition of mercury to Canadian-produced consumer paints for interior use was prohibited in 1991. Mercury may have remained in paints after 1991, however, as a result of impurities in the paint ingredients or cross-contamination due to other manufacturing processes. The *Surface Coating Materials Regulations* made under the Hazardous Products Act set a maximum total mercury concentration of 10 mg/kg (0.001 percent) for surface coating materials (including paint). This criterion level applies to the sale and importation of new surface coating materials.

Mercury-containing thermostats and silent light switches are mercury tilt switches which are small tubes with electrical contacts at one end of the tube. A mercury tilt switch is usually present when no switch is visible. Mercury switches often have the word "TOP" stamped on the upper end of the switch, which is visible after removing the cover plate. If mercury switches are to be removed, the entire switch should be removed and placed into a suitable container for storage and disposal.

Waste light tubes generated during renovations or building demolition and waste mercury from equipment must either be recycled or disposed of in accordance with the requirements of B.C. Reg. 63/88 – *Hazardous Waste Regulation*.

Waste mercury is classified as "leachable toxic waste" if the extraction criterion value prescribed in Table 1 of Schedule 4 of the regulation is exceeded. Waste mercury from mercury switches or gauges should be properly collected and shipped to a recycling facility or disposed of as a hazardous waste. Removal of mercury-containing equipment (e.g., switches, gauges, controls, etc.) should be carried out in a manner which prevents spillage and exposure to workers.

2.4 Silica

Silica exists in several forms of which crystalline silica is of most concern with respect to potential worker exposures. Quartz is the most abundant type of crystalline silica. Some commonly used construction materials containing silica include brick, refractory brick, concrete, concrete block, cement, mortar, rock and stone, sand, fill dirt, topsoil and asphalt containing rock or stone.

Employers in British Columbia are required to develop an exposure control plan (ECP) when workers are or may be exposed to airborne silica dust in excess of 50 percent of the exposure limit. The WorkSafe BC guidance document "Developing a Silica Exposure Control Plan" provides information on each of the required elements of an ECP, including safe work procedures for controlling exposure to silica during construction activities.

2.5 PCBs

In most institutional and commercial facilities and in smaller industrial facilities, the primary source of equipment potentially containing PCBs is fluorescent and H.I.D. light ballasts. Small transformers may also be present. In larger industrial facilities, larger transformers and switch gear containing, or potentially containing, PCBs may also be present.

PCBs were also commonly added to industrial paints from the 1940s to the late 1970s. PCBs were added directly to the paint mixture to act as a fungicide, to increase durability and flexibility, to improve resistance to fires and to increase moisture resistance. The use of PCBs in new products was banned in Canada in the 1970s. PCB amended paints were used in speciality industrial/institutional applications prior to the 1970s including government buildings and equipment such as industrial plants, radar sites, ships as well as non-government rail cars, ships, grain bins, automobiles and appliances.

Removal of in-service equipment containing PCBs, such as fluorescent light ballasts, capacitors and transformers, is subject to the requirements of the federal *PCB Regulations*.

The PCB Regulations, which came into force on 5 September 2008, were made under the *Canadian Environmental Protection Act*, 1999 (CEPA 1999) with the objective of addressing the risks posed by the use, storage and release to the environment of PCBs, and to accelerate their destruction. The PCB Regulations set different end-of-use deadlines for equipment containing PCBs at various concentration levels.

The Regulations Amending the PCB Regulations and Repealing the Federal Mobile PCB Treatment and Destruction Regulations were published on 23 April 2014, in the Canada Gazette, Part II, and came into force on 1 January 2015. The most notable part of the amendments is the addition of an end-of-use deadline date of 31 December 2025 for specific electrical equipment located at electrical generation, transmission and distribution facilities.

"PCB wastes" are defined in B.C. Reg. 63/88 – Hazardous Waste Regulation as PCB liquid, PCB solid and PCB equipment that have been taken out of service for the purpose of treatment, recycling, reuse or disposal or for the purpose of storage prior to treatment, recycling, reuse or disposal. "PCB liquid" means any liquid containing more than 50 parts per million by weight of chlorobiphenyls. "PCB solid" means any material or substance other than PCB liquid that contains or is contaminated with chlorobiphenyls at a concentration greater than 50 parts per million by weight of chlorobiphenyls. "PCB equipment" means a manufactured item that contains or is contaminated with PCB liquids or PCB solids and includes transformers, capacitors and containers.

2.6 Ozone-Depleting Substances and Halocarbons

In Canada, the federal, provincial and territorial governments have legislation in place for the protection of the ozone layer and management of ozone-depleting substances and their halocarbon alternatives. The use and handling of these substances are regulated by the provinces and territories in their respective jurisdictions, and through the *Federal Halocarbon Regulations, 2003* (FHR 2003) for refrigeration, air-conditioning, fire-extinguishing and solvent systems under federal jurisdiction.

The FHR 2003 were published in August 2003 and amended in July 2009 under the authority of the *Canadian Environmental Protection Act, 1999*. The purpose of the FHR 2003 is to reduce and prevent emissions of ozone-depleting substances and of their halocarbon alternatives to the environment from air-conditioning units, refrigeration, fire-extinguishing and solvent systems that are:

- located on federal or aboriginal lands; or
- owned by federal departments, board agencies, Crown corporations, or federal works and undertakings.

The FHR 2003 replaced the former *Federal Halocarbon Regulations* and incorporated new provisions to achieve an orderly transition from CFCs and Halons to alternative substances and technologies, reflecting *Canada's Strategy to Accelerate the Phase-Out of CFC and Halon Uses and to Dispose of the Surplus Stocks.*

Under the FHR 2003, a person who installs, services, leak tests, or charges a refrigeration system or an air conditioning system or does any other work on the system that may result in the release of a halocarbon must do so in accordance with the *Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*.

Some of the requirements of FHR 2003 include:

- certification is required for all persons testing, repairing, filling or emptying equipment containing ozone-depleting substances and their halocarbon alternatives;

- no person shall store, transport or purchase a halocarbon unless it is in a container designed and manufactured to be refilled and to contain that specific type of halocarbon;
- before dismantling, decommissioning or destruction of any system, a person shall recover all halocarbons contained in the system into a container designed and manufactured to be refilled and to contain that specific type of halocarbon;
- before dismantling, decommissioning or destruction or destroying a system, a person shall affix a notice to the system containing information as required in Column 3, Item 1 of Schedule 2. This information includes the name and address of the owner of the system; name of the operator of the system, specific location of the system before its dismantling, decommissioning or destruction; description of the system; name of service technician who recovered the halocarbons; certificate number of the service technician (if applicable); name of employer of service technician (if applicable); type and quantity of halocarbon and date recovered; type and charging capacity of the system; and final destination of the system; and
- in the case of dismantling, decommissioning or destruction of any system, the owner shall keep a record of the information contained in the notice as described above.

2.7 Rodent Droppings

According to the Health Canada (in collaboration with the Public Health Agency of Canada) article "*It's Your Health – Hantaviruses*", dated August 2009, Hantaviruses are found in the droppings, urine, and saliva of infected rodents and humans can contact the virus from breathing in airborne particles or from being bitten. In Canada, a hantavirus capable of causing disease in humans – named Sin Nimbre virus – has been identified in deer mice. Although the risk in Canada is low, when it happens, the disease can be very severe.

Exposure to hantaviruses can cause a rare, but often fatal, disease called Hantavirus pulmonary syndrome (HPS). The earliest documented case of HPS in Canada was contracted in Alberta in 1989. Since then, there have been over 70 confirmed cases. Most of the cases occurred in western Canada (Manitoba, Saskatchewan, Alberta and British Columbia), except for one case in Quebec.

Hantavirus is typically transmitted by breathing particles in air from the droppings, urine and saliva of infected rodents. However, there have been a small number of reported cases of HPS believed to have been contracted through rodent bites.

2.8 Mould

Moulds are forms of fungi that are found everywhere both indoors and outdoors all year round. Outdoors, moulds live in the soil, on plants and on dead and decaying matter. More than 1000 different kinds of indoor moulds have been found in buildings. Moulds spread and reproduce by making spores, which are all small and light-weight, able to travel through air, capable of resisting dry, adverse environmental conditions, and hence capable of surviving a long time. Moulds need moisture and nutrients to grow and their growth is stimulated by warm, damp and humid conditions.

Recommended work practices are outlined in the following document:

- *Mould Guidelines for the Canadian Construction Industry*. Standard Construction Document CCA 82 2004. Canadian Construction Association.

3 METHODOLOGY

3.1 Asbestos

Bulk sampling and analysis was performed in general accordance with the requirements specified in B.C. Reg. 296/97 and in the WorkSafe BC publication *Safe Work Practices for Handling Asbestos*.

Determination of the locations of asbestos-containing materials was made based on the results of bulk sample analyses, visual observations and physical characteristics of the applications as well as our knowledge of the uses of asbestos in building materials.

Analysis of bulk samples was performed following EPA Method 600/R-93/116 in conformity with the requirements specified in B.C. Reg. 296/97.

3.2 Lead

Samples of select, representative paint applications were collected during the course of the site inspection.

3.3 Mercury

The presence of equipment which may contain mercury, such as fluorescent light tubes, thermometers, gauges, etc. observed during the course of our site inspection was recorded.

3.4 Silica

The presence of silica-containing materials observed during the course of our site inspection was documented. Silica is known to be a constituent of brick, concrete, cement, etc. Sampling and laboratory analysis are not required to make this determination.

3.5 PCBs

The presence or absence of fluorescent lights was documented during the course of our survey to determine whether there were any of the T12 type which may therefore contain PCB ballasts.

3.6 Rodent Droppings

The presence of rodent droppings in all accessible areas was recorded during the site inspections by Arcadis staff.

3.7 Mould

The presence of any "suspect" mould observed during the course of our site inspection was documented. "Suspect" mould is typically a coloured, textured substance or discolouration or staining on a building material surface which, based on our experience, may be mould growth. The adjective "suspect" is used where the presence of mould has not been confirmed by laboratory analysis.

4 RESULTS AND DISCUSSION

4.1 Asbestos

During the course of our hazardous materials assessment, representative bulk samples of materials were collected by Arcadis staff. The samples were forwarded to EMSL Canada Inc. for asbestos analyses. EMSL holds a current Certificate of Accreditation for Bulk Asbestos Fibre Analysis under the Voluntary Accreditation Program (NVLAP). The results of the bulk sample analyses for asbestos content are provided in Table 4.1, and the laboratory report is provided in Appendix B.

Table 4.1. Summary of Results of Analyses of Bulk Samples for Asbestos Content

Sample Number	Sample Location	Sample Description	Asbestos Content
A1A	AHU 102 North	Brown Air Duct Mastic	None detected
A1B	AHU 102 East	Brown Air Duct Mastic	None detected
A1C	AHU 102 West	Brown Air Duct Mastic	None detected
A2A	Behind AHU 102 North	Grey Air Duct Mastic	None detected
A2B	Behind AHU 102 North	Grey Air Duct Mastic	None detected
A2C	Behind AHU 102 North	Grey Air Duct Mastic	None detected
A3A	Behind AHU 102 East	Drywall Joint Compound	None detected
A3B	Behind AHU 102 West	Drywall Joint Compound	None detected
A3C	Behind AHU 102 North	Drywall Joint Compound	None detected
A4A	Under AHU 102 East	Roof Tar/Membrane	None detected
A4B	Under AHU 102 East	Roof Tar/Membrane	None detected
A4C	Under AHU 102 East	Roof Tar/Membrane	None detected
A5A	Parapet by AHU 102 North	Roof Tar/Membrane	None detected
A5B	Parapet by AHU 102 North	Roof Tar/Membrane	None detected
A5C	Parapet by AHU 102 North	Roof Tar/Membrane	None detected
A6A	Parapet by AHU 102 North	Stucco	None detected
A6B	Parapet by AHU 102 North	Stucco	None detected

A6C	Parapet by AHU 102 North	Stucco	None detected
A7A	AHU 102 East	Flexible Air Duct Joint	None detected
A7B	AHU 102 North	Flexible Air Duct Joint	None detected
A8A	AHU 102 East	Pipe Insulation Cap	None detected
A8B	AHU 102 West	Pipe Insulation Cap	None detected

Based on visual observations and results of laboratory analyses of samples collected by Arcadis, no asbestos-containing materials were found to be present in Building M3 Living Unit/Penthouse Mechanical Room.

Photographs are provided in Appendix C.

Asbestos may also be present in materials which were not sampled during the course of the asbestos survey carried out by Arcadis, including, but not limited to, components of electrical equipment (e.g. electric wiring insulation, non-metallic sheathed cable, electrical panel partitions, arc chutes, high-grade electrical paper, etc.) and/or in locations that are presently inaccessible (e.g., in pipe chases, behind walls and beneath vinyl and wood flooring). Asbestos may also be present in the form of vermiculite insulation in cavities in concrete or cement block walls (used as in-fill insulation). Confirmatory testing of any such materials could be undertaken as the need arises (i.e., at the time of renovations) or the materials can be assumed to contain asbestos based on findings in adjacent areas.

If any materials which may contain asbestos and which were not tested during the course of the hazardous materials survey are discovered during any renovation activities, or if any of the materials listed above are encountered, or may be affected by the renovation activities, the work shall not proceed until such time as the required notifications have been made and an appropriate course of action is determined.

4.2 Lead

Two samples of the predominant paint were collected by Arcadis during the course of the investigation. The samples were submitted to EMSL Canada Inc. and Maxxam Analytics for analysis of lead content. The results of the analyses is presented in Table 4.3, and the laboratory report is provided in Appendix B.

Lead was detected at a level above the WorkSafe BC guideline value of 600 mg/kg and above the *Surface Coating Materials Regulations* maximum concentration of 90 mg/kg in both samples of paint. Where one colour of paint is indicated in the sample descriptions in Table 4.2, only one layer of paint was observed.

The paint applications were noted to be generally in good condition at the time of the survey by Arcadis. Prior to any renovation work, affected lead-containing paint should be handled following the measures and procedures outlined in the WorkSafe BC publication *Lead-Containing Paints and Coatings, Preventing Exposure in the Construction Industry*.

Table 4.2. Summary of Results of Analyses of Bulk Samples for Lead Content

Sample Number	Sample Location	Sample Description	Condition	Lead Content (mg/kg)
AL1	Penthouse Mechanical Room	Tan Concrete Floor Pain	Good	**14000 mg/kg**
AL2	Penthouse Mechanical Room	Green/Grey Paint on AHU	Good	**3400 mg/kg**

NOTES:

mg/kg = milligrams lead per kilogram paint.

< = less than.

1 mg/kg = 1 part per million (ppm).

4.3 Mercury

No mercury-containing thermostats were observed during the course of our site inspection. Fluorescent light tubes were observed throughout the study area. Mercury should be assumed to be present as a gas in all fluorescent light tubes. If any fluorescent light tubes are removed, the light tubes should be recycled for mercury.

Proper procedures for removing and handling mercury-containing fluorescent light tubes typically involve:

- ensuring that electrical power to light fixtures has been disconnected and locked out;
- taking all necessary precautions to ensure that fluorescent lamp tubes are removed in a manner that prevents breakage; and
- transporting fluorescent lamp tubes to a licensed processing location for separation and recovery of mercury.

4.4 Silica

Materials observed in the study area which could contain silica included drywall joint compound, gypsum board, concrete, concrete block, brick and mortar.

The WorkSafe BC guidance document Developing a Silica Exposure Control Plan, provides guidance in controlling exposure to silica dust during construction/renovation activities.

4.5 PCBs

Fluorescent lights were observed throughout the study area during the course of our site inspection. Light ballasts, such as those associated with the type of fluorescent lights (T8s) observed in the study area, are

usually an electronic-type which do not contain PCBs, however, this should be confirmed by an electrician at the time of dismantling of the lights.

4.6 Rodent Droppings

Rodent droppings were not observed in the study area during the course of our site inspection.

4.7 Mould

No suspect mould was observed in the study area during the course of our site inspection.

During renovation activities, any mould-impacted materials that may be uncovered/discovered should be remediated following the measures and procedures outlined in the Canadian Construction Association Standard Construction Document CCA-82 2004 - Mould guidelines for the Canadian Construction Industry.

5 RECOMMENDATIONS

We recommend the following on the basis of the findings of the hazardous material assessment outlined in this report:

1. Ensure that a risk assessment is performed and an exposure control plan is developed for lead-containing paint prior to renovations.

2. Prior to undertaking renovation activities:

   - ensure that a licensed electrician inspects ballasts to determine whether or not any light ballasts may contain PCBs, if they are affected by the proposed project. Guidance in identification of PCB ballasts is provided in the Environment Canada publication titled "Identification of Lamp Ballasts Containing PCBs. Report EPS 2/CC/2 (revised)", August 1991;
   - develop a silica exposure control plan; and
   - remove all fluorescent light tubes, if they are affected by the proposed project, and transport to a licensed processing location for separation and recovery of mercury.

6 USE AND LIMITATIONS OF HAZARDOUS MATERIALS SURVEY REPORT

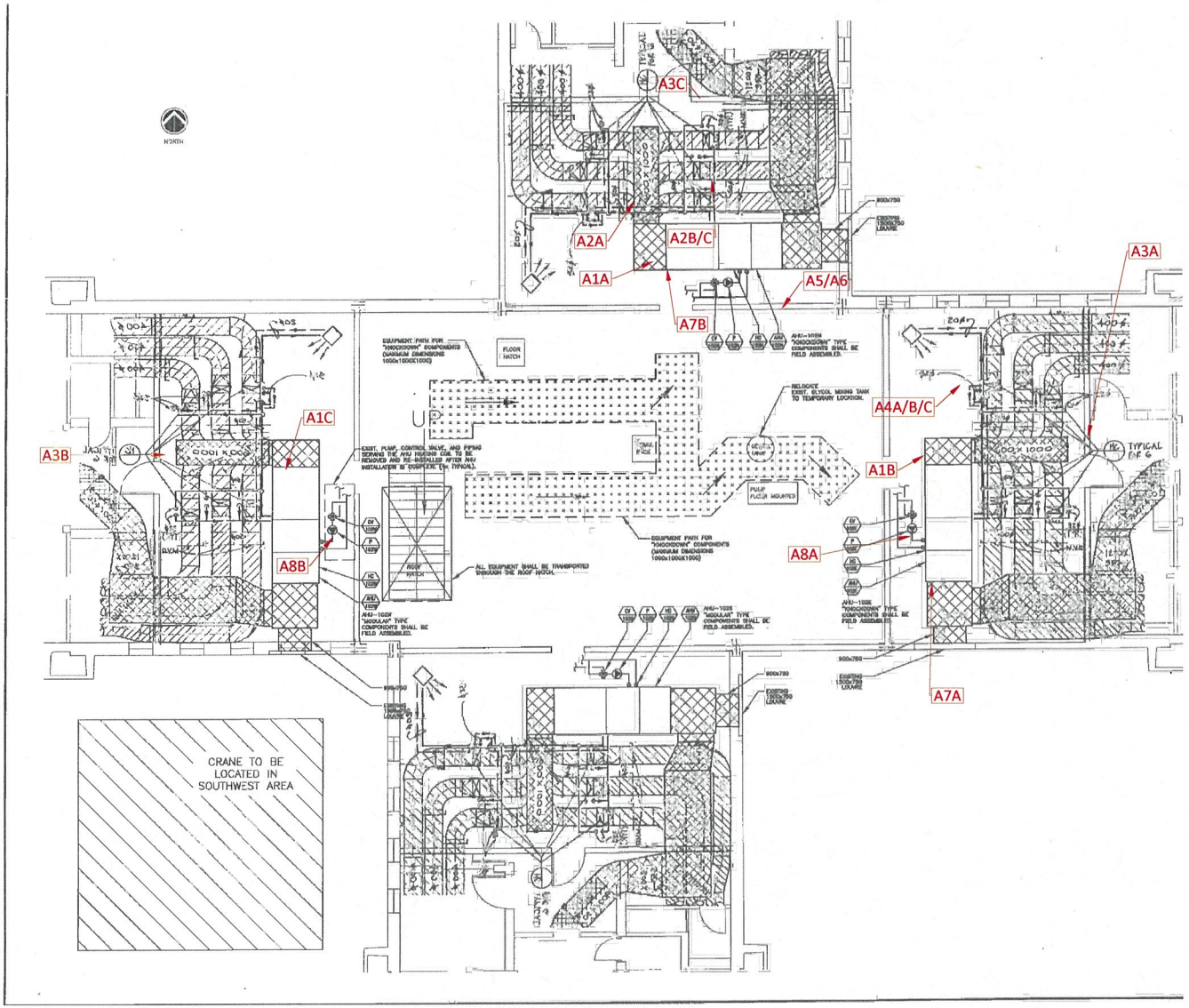
This report, prepared for Public Works and Government Services Canada, on behalf of Correctional Service Canada, does not provide certification or warranty, expressed or implied, that the investigation conducted by Arcadis identified all hazardous materials in the study area of Building M3 Living Unit/Penthouse Mechanical Room. The work undertaken by Arcadis was directed to provide information on the presence of hazardous materials in the study area in building construction materials based on visual inspection of readily accessible areas of the building, and on the results of laboratory analysis of a limited number of bulk samples of material for asbestos content and laboratory analysis of a limited number of paint samples for lead content.

The material in this report reflects Arcadis' best judgment in light of the information available at the time of the investigation, which was performed on November 9 and 10, 2016.

This report was prepared by Arcadis for Public Works and Government Services Canada, on behalf of Correctional Service Canada. Any use which any other party makes of the report, or reliance on, or decisions to be based on it, is the responsibility of such parties.

APPENDIX A

Floor Plans



LEGEND

A1A Sample Location (Asbestos)

Title MASTQUI INSTITUTION
BUILDING M3 LIVING UNIT/PENTHOUSE/ MECHANICAL ROOM

Project HAZARDOUS MATERIALS ASSESSMENT

Client PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Project	Drawn By: JB	Plot Size: 11X17"	DECEMBER 2016
ARCADIS			FIGURE 1

APPENDIX B

Laboratory Reports

EMSL Canada Inc.

4506 Dawson Street Burnaby, BC V5C 4C1
Phone/Fax: 604-757-3158 / (604) 757-4731
http://www.EMSL.com / vancouverlab@EMSL.com

EMSL Canada Order 691601487
Customer ID: 55DCSL97
Customer PO: 702358
Project ID:

Attn: Kelly Smith
ARCADIS Canada Inc.
121 Granton Drive
Unit 12
Richmond Hill, ON L4B 3N4

Proj: 702358

Phone: (905) 882-5984
Fax: (905) 882-8962
Collected:
Received: 11/10/2016
Analyzed: 11/17/2016

Test Report: Asbestos Analysis in Bulk Material for Occupational Health and Safety British Columbia Regulation 188/2011 via EPA 600/R-93/116 Method

Client Sample ID: A1A ***Lab Sample ID:*** **691601487-0001**
Sample Description: BUILDING M3/BROWN AIR DUCT MASTIC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Brown	10%	90%	None Detected	

Client Sample ID: A1B ***Lab Sample ID:*** **691601487-0002**
Sample Description: BUILDING M3/BROWN AIR DUCT MASTIC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Brown	8%	92%	None Detected	

Client Sample ID: A1C ***Lab Sample ID:*** **691601487-0003**
Sample Description: BUILDING M3/BROWN AIR DUCT MASTIC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	Red	5%	95%	None Detected	

Client Sample ID: A2A ***Lab Sample ID:*** **691601487-0004**
Sample Description: BUILDING M3/GREY AIR DUCT MASTIC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Gray	0%	100%	None Detected	

Client Sample ID: A2B ***Lab Sample ID:*** **691601487-0005**
Sample Description: BUILDING M3/GREY AIR DUCT MASTIC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Gray	0%	100%	None Detected	

Client Sample ID: A2C ***Lab Sample ID:*** **691601487-0006**
Sample Description: BUILDING M3/GREY AIR DUCT MASTIC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	Gray	0%	100%	None Detected	

Client Sample ID: A3A ***Lab Sample ID:*** **691601487-0007**
Sample Description: BUILDING M3/DWJC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	White	0%	100%	None Detected	

EMSL Canada Inc.

4506 Dawson Street Burnaby, BC V5C 4C1
Phone/Fax: 604-757-3158 / (604) 757-4731
http://www.EMSL.com / vancouverlab@EMSL.com

EMSL Canada Order 691601487
Customer ID: 55DCSL97
Customer PO: 702358
Project ID:

Test Report: Asbestos Analysis in Bulk Material for Occupational Health and Safety British Columbia Regulation 188/2011 via EPA 600/R-93/116 Method

Client Sample ID: A3B **Lab Sample ID:** 691601487-0008
Sample Description: BUILDING M3/DWJC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	White	0%	100%	None Detected	

Client Sample ID: A3C **Lab Sample ID:** 691601487-0009
Sample Description: BUILDING M3/DWJC

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	White	0%	100%	None Detected	

Client Sample ID: A4A **Lab Sample ID:** 691601487-0010
Sample Description: BUILDING M3/ROOF TAR/MEMBRANE

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Black	0%	100%	None Detected	

Client Sample ID: A4B **Lab Sample ID:** 691601487-0011
Sample Description: BUILDING M3/ROOF TAR/MEMBRANE

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Black	0%	100%	None Detected	

Client Sample ID: A4C **Lab Sample ID:** 691601487-0012
Sample Description: BUILDING M3/ROOF TAR/MEMBRANE

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	Black	0%	100%	None Detected	

Client Sample ID: A5A **Lab Sample ID:** 691601487-0013
Sample Description: BUILDING M3/ROOF TAR/MEMBRANE

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Black	0%	100%	None Detected	

Client Sample ID: A5B **Lab Sample ID:** 691601487-0014
Sample Description: BUILDING M3/ROOF TAR/MEMBRANE

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Black	0%	100%	None Detected	

Client Sample ID: A5C **Lab Sample ID:** 691601487-0015
Sample Description: BUILDING M3/ROOF TAR/MEMBRANE

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	Black	0%	100%	None Detected	

EMSL Canada Inc.

4506 Dawson Street Burnaby, BC V5C 4C1
Phone/Fax: 604-757-3158 / (604) 757-4731
http://www.EMSL.com / vancouverlab@EMSL.com

EMSL Canada Order 691601487
Customer ID: 55DCSL97
Customer PO: 702358
Project ID:

Test Report: Asbestos Analysis in Bulk Material for Occupational Health and Safety British Columbia Regulation 188/2011 via EPA 600/R-93/116 Method

Client Sample ID: A6A **Lab Sample ID:** 691601487-0016
Sample Description: BUILDING M3/STUCCO

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	White	0%	100%	None Detected	

Client Sample ID: A6B **Lab Sample ID:** 691601487-0017
Sample Description: BUILDING M3/STUCCO

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	White	0%	100%	None Detected	

Client Sample ID: A6C **Lab Sample ID:** 691601487-0018
Sample Description: BUILDING M3/STUCCO

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	White	0%	100%	None Detected	

Client Sample ID: A7A **Lab Sample ID:** 691601487-0019
Sample Description: BUILDING M3/FLEXIBLE AIR DUCT JOINT

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Beige	30%	70%	None Detected	

Client Sample ID: A7B **Lab Sample ID:** 691601487-0020
Sample Description: BUILDING M3/FLEXIBLE AIR DUCT JOINT

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/16/2016	Tan	30%	70%	None Detected	

Client Sample ID: A8A **Lab Sample ID:** 691601487-0021
Sample Description: BUILDING M3/PIPE INSULATION CAP

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	White	5%	95%	None Detected	

Client Sample ID: A8B **Lab Sample ID:** 691601487-0022
Sample Description: BUILDING M3/PIPE INSULATION CAP

TEST	Analyzed Date	Color	Non-Asbestos Fibrous	Non-Asbestos Non-Fibrous	Asbestos	Comment
PLM	11/17/2016	White	0%	100%	None Detected	

EMSL Canada Inc.
4506 Dawson Street Burnaby, BC V5C 4C1
Phone/Fax: 604-757-3158 / (604) 757-4731
http://www.EMSL.com / vancouverlab@EMSL.com

EMSL Canada Order 691601487
Customer ID: 55DCSL97
Customer PO: 702358
Project ID:

Test Report: Asbestos Analysis in Bulk Material for Occupational Health and Safety British Columbia Regulation 188/2011 via EPA 600/R-93/116 Method

Analyst(s):

Kathleen Cruz PLM (8)
Nicole Yeo PLM (14)

Reviewed and approved by:

Nicole Yeo, Laboratory Manager
or Other Approved Signatory

None Detected = <0.1%. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. Samples received in good condition unless otherwise noted. This report must not be used to claim product endorsement by NVLAP of any agency of the U.S. Government.

Samples analyzed by EMSL Canada Inc. Burnaby, BC

Report amended: 11/29/201616:52:58 Replaces initial report from: 11/17/201614:54:37 Reason Code: Client-Other (see report comment)

EMSL Canada Inc.
2756 Slough Street, Mississauga, ON L9T 5N4
Phone/Fax: 289-997-4602 / (289) 997-4607
http://www.EMSL.com torontolab@emsl.com

EMSL Canada Or	551612349
CustomerID:	55DCSL97
CustomerPO:	702358
ProjectID:	

Attn: **Kelly Smith**
ARCADIS Canada Inc.
121 Granton Drive
Unit 12
Richmond Hill, ON L4B 3N4

Project: **702358**

Phone:	(905) 882-5984
Fax:	(905) 882-8962
Received:	11/15/16 10:13 AM
Collected:	

Test Report: Lead in Paint Chips by Flame AAS (SW 846 3050B/7000B)*

Client Sample Description	*Lab ID*	*Collected*	*Analyzed*	*Lead Concentration*
AL1	*551612349-0001*		11/18/2016	14000 mg/Kg
	Site: TAN CONCRETE FLOOR			

Rowena Fanto, Lead Supervisor
or other approved signatory

*Analysis following Lead in Paint by EMSL SOP/Determination of Environmental Lead by FLAA. Reporting limit is 0.010 % wt based on the minimum sample weight per our SOP. Unless noted, results in this report are not blank corrected. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities. Samples received in good condition unless otherwise noted. "<" (less than) result signifies that the analyte was not detected at or above the reporting limit. Measurement of uncertainty is available upon request. The QC data associated with the sample results included in this report meet the recovery and precision requirements unless specifically indicated otherwise. Definitions of modifications are available upon request.

Samples analyzed by EMSL Canada Inc. Mississauga, ON A2LA Accredited Environmental Testing Cert #2845.08

Initial report from 11/22/2016 08:16:20

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: 51363
Site Location: MATSQUI-M3
Your C.O.C. #: G110347

Attention:Kelly Smith

ARCADIS Canada Inc.
121 GRANTON DRIVE, UNIT 12
RICHMOND HILL, ON
CANADA L4B 3N4

Report Date: 2016/11/28
Report #: R2307582
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B6A6221
Received: 2016/11/25, 19:37

Sample Matrix: PAINT
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by ICP-AES (acid extr. solid)	1	2016/11/28	2016/11/28	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.

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.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Amandeep Nagra, Account Specialist
Email: ANagra@maxxam.ca
Phone# (604)639-2602

==========

This report has been generated and distributed using a secure automated process.
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 #: B6A6221
Report Date: 2016/11/28

ARCADIS Canada Inc.
Client Project #: 51363
Site Location: MATSQUI-M3

ELEMENTS BY ATOMIC SPECTROSCOPY (PAINT)

Maxxam ID		QD1716		
Sampling Date		2016/11/21		
COC Number		G110347		
	UNITS	**AL2**	**RDL**	**QC Batch**
Total Metals by ICP				
Total Lead (Pb)	mg/kg	3400	3.0	8486286
RDL = Reportable Detection Limit				

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B6A6221
Report Date: 2016/11/28

ARCADIS Canada Inc.
Client Project #: 51363
Site Location: MATSQUI-M3

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 #: B6A6221
Report Date: 2016/11/28

ARCADIS Canada Inc.
Client Project #: 51363
Site Location: MATSQUI-M3

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
8486286	JXV	QC Standard	Total Lead (Pb)	2016/11/28		93	%	80 - 120
8486286	JXV	Method Blank	Total Lead (Pb)	2016/11/28	<3.0		mg/kg	
8486286	JXV	RPD	Total Lead (Pb)	2016/11/28	NC		%	35

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 (one or both samples < 5x RDL).

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B6A6221
Report Date: 2016/11/28

ARCADIS Canada Inc.
Client Project #: 51363
Site Location: MATSQUI-M3

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Ph.D., P.Chem., Scientific Specialist

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.

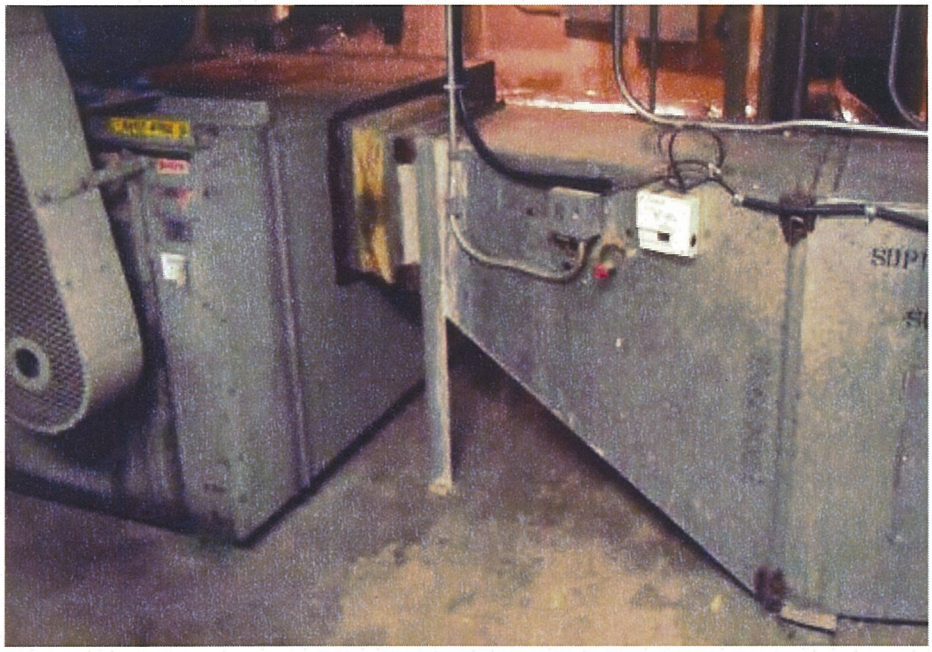
Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

APPENDIX C

Photographs

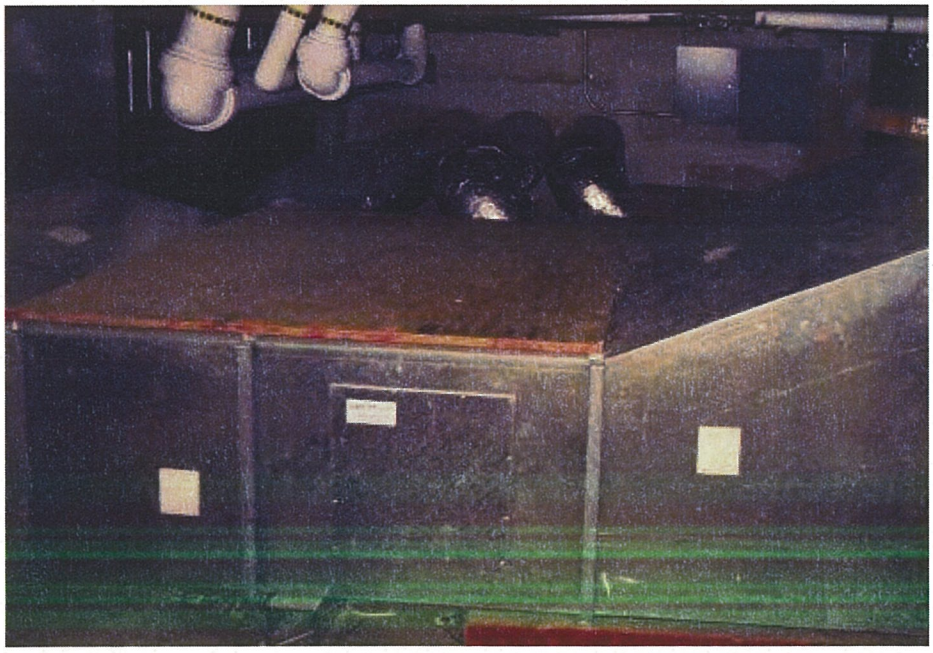
ARCADIS Design & Consultancy for natural and built assets

Appendix C – Photos
Hazardous Materials Survey
Matsqui Institution Building
M3 Living Unit/Penthouse
Mechanical Room,
Abbotsford, British Columbia



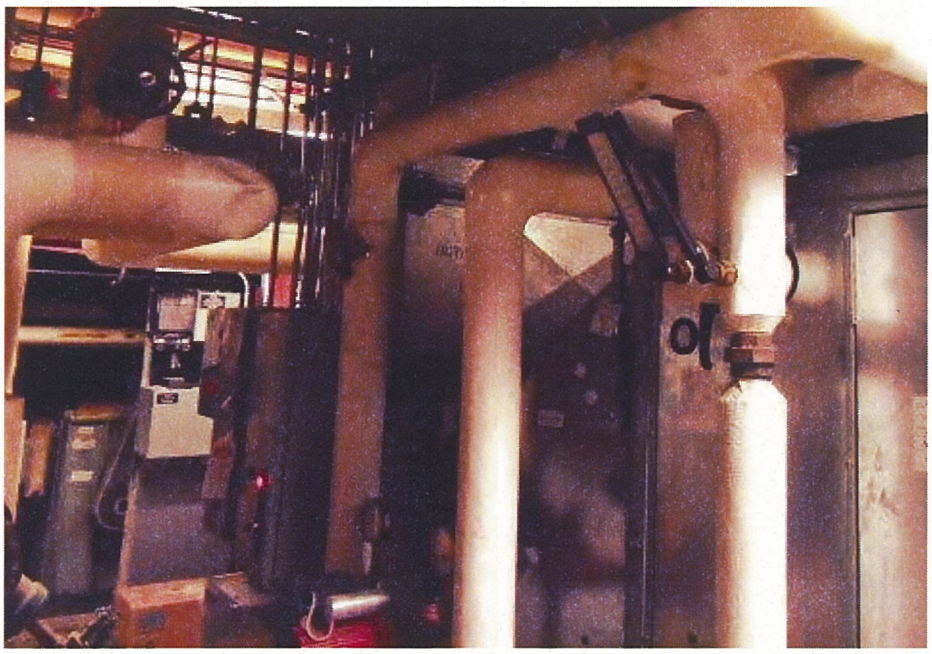
Photograph 1: AHU 102 South

Non-asbestos brown air duct mastic on all original ducts including all connections, corners/joints –(samples A1A/B/C)



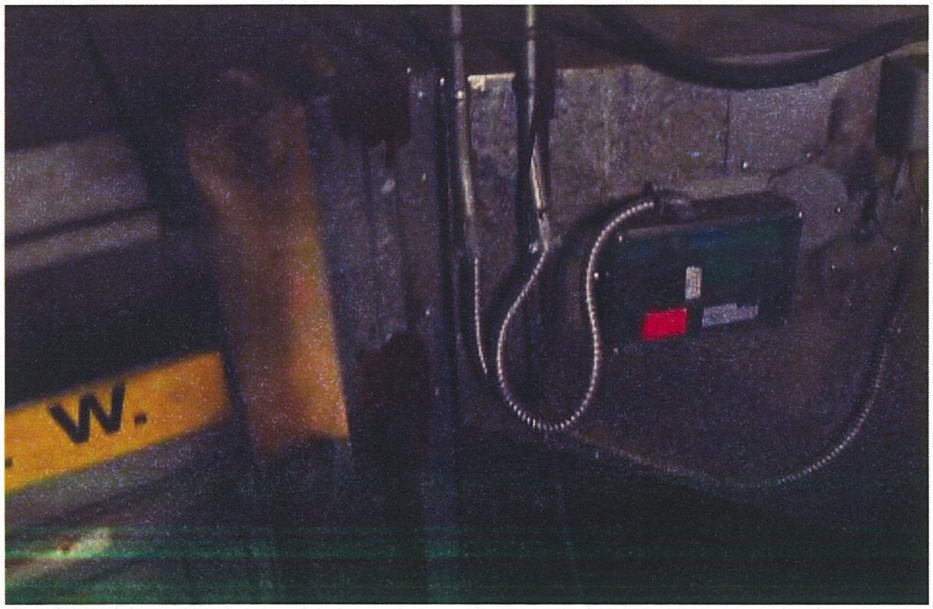
Photograph 2: AHU 102 West

Non-asbestos drywall joint compound observed (sample A3B).



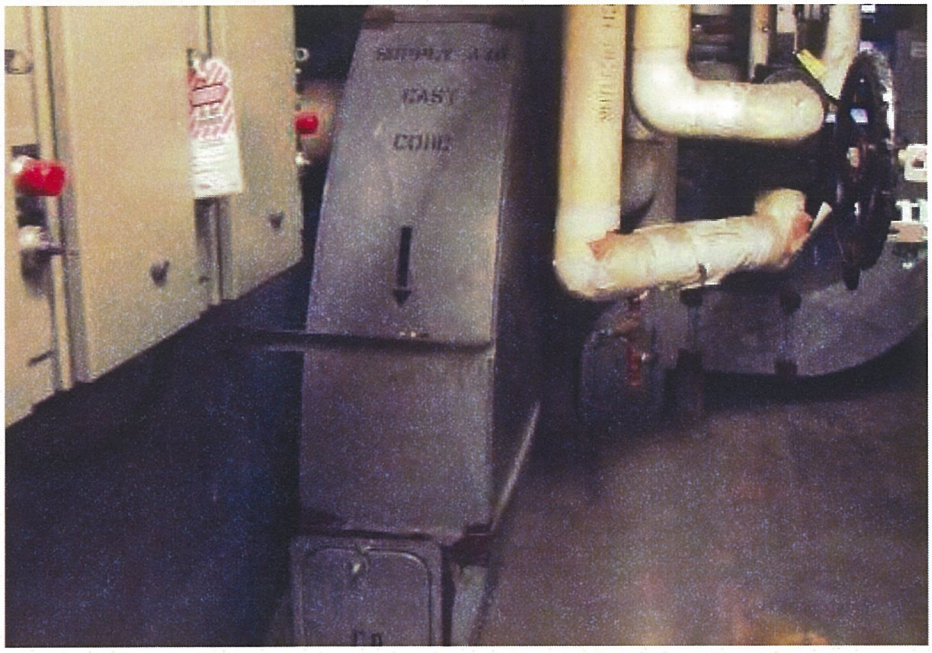
Photograph 4:

Non-asbestos fiberglass thermal insulation applied to ducts of new AHUs.



Photograph 5: AHU 102 West –

Non-asbestos brown air duct mastic (sample A1C)

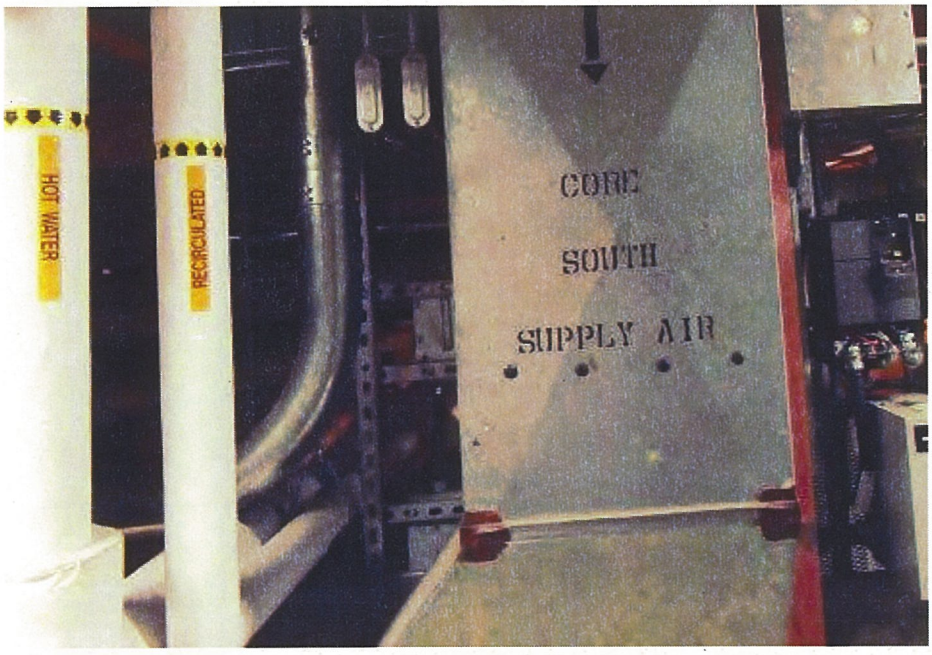


Photograph 6:

Non-asbestos fiberglass thermal insulation applied to pipes and elbows. The boiler is not expected to be affected by the proposed project.

Photograph 7:

Non-asbestos flexible air duct joints (sample A7)



Photograph 8:

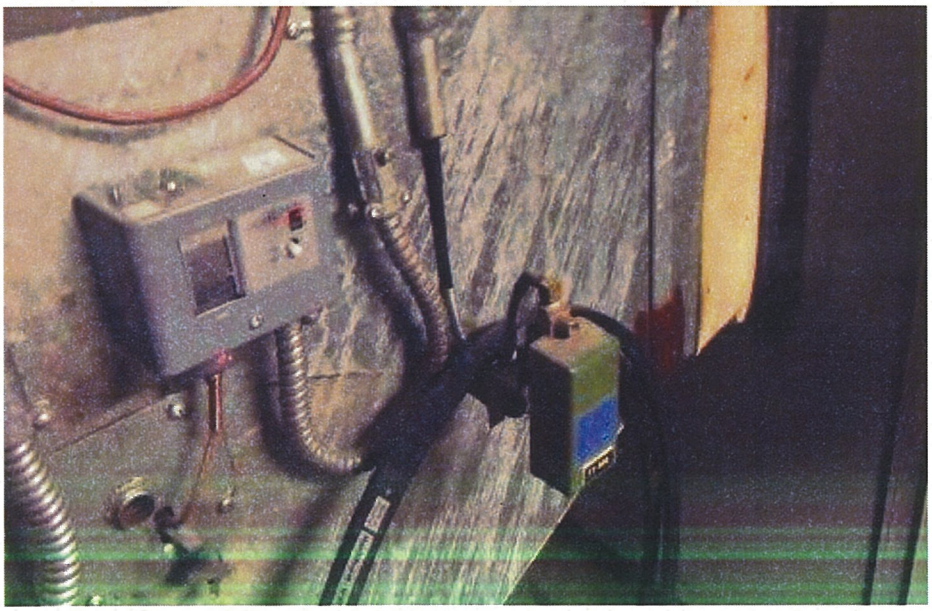
Non-asbestos brown air duct mastic on air duct corners

Photograph 9:

Non-asbestos fiberglass thermal insulation with foil wrap applied to air ducts.

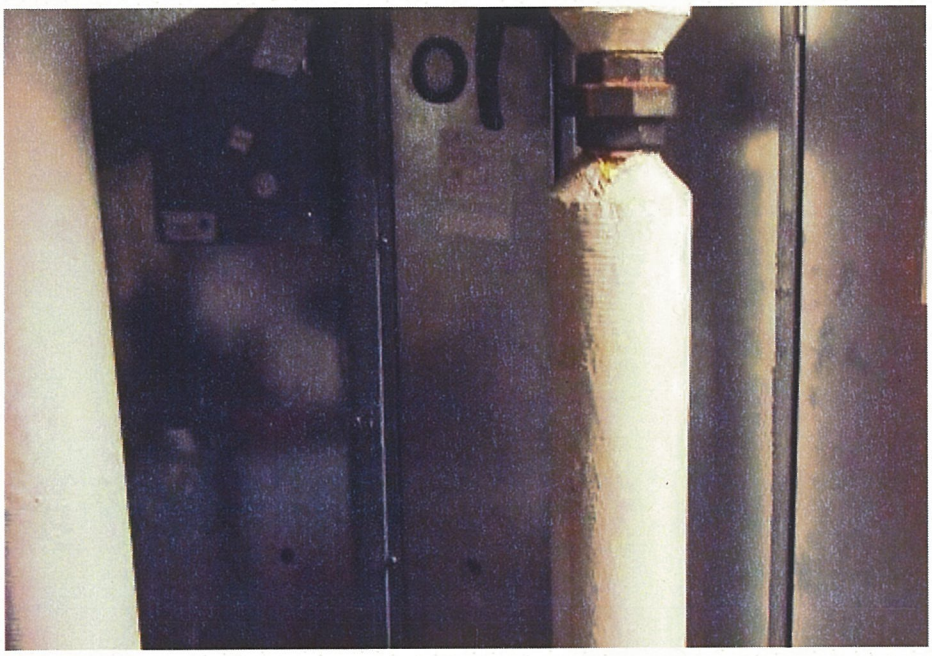
Photograph 10: AHU 102 East

Non-asbestos floor tar/membrane (samples A4A/B/C).

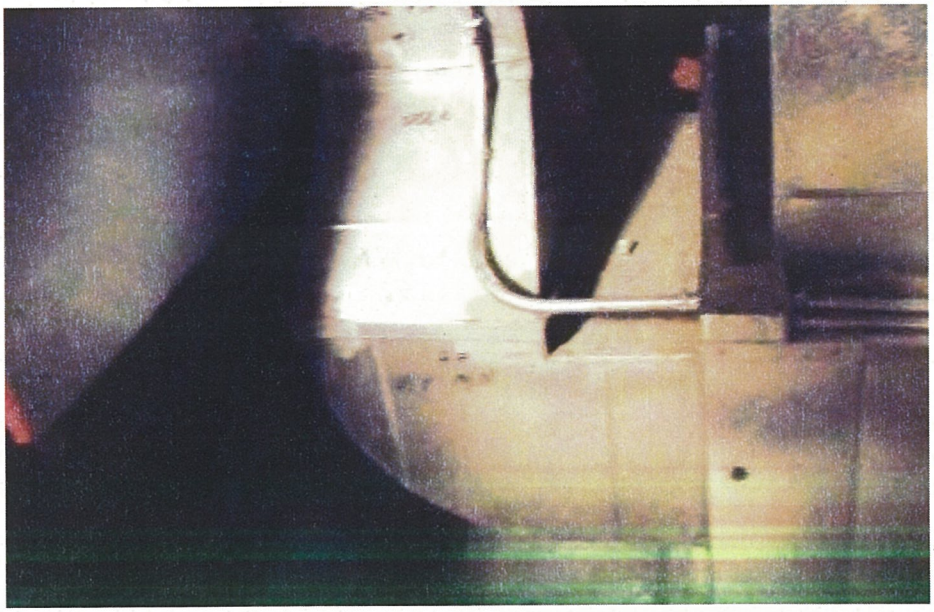


Photograph 11:

Non-asbestos flexible air duct joint (sample A7B)



Photograph 12: Non-asbestos capping material on insulation ends (sample A8B)

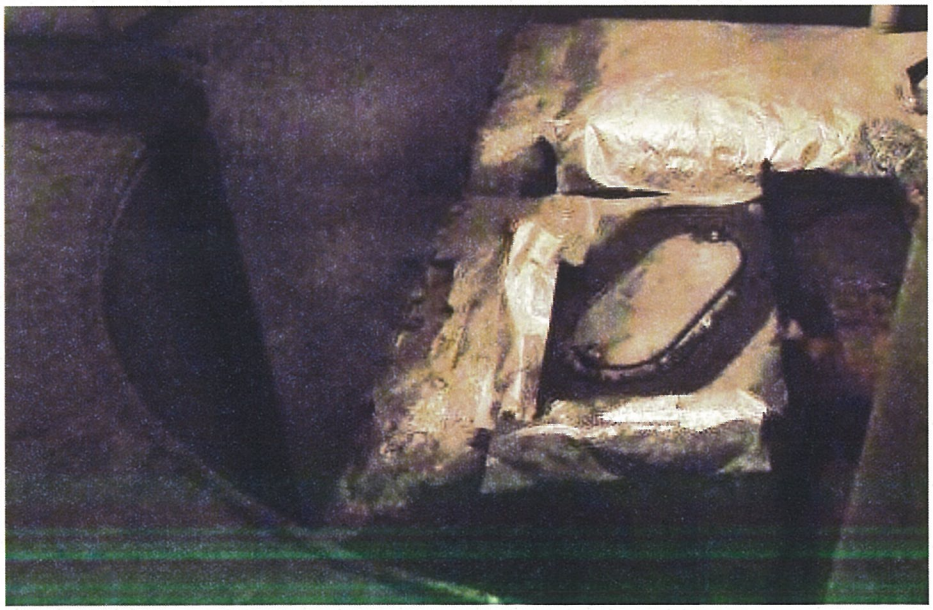


Photograph 13:

Non-asbestos grey air duct mastic (sample A2A)

Photograph 14:

Grey/green paint on AHU (sample AL2)

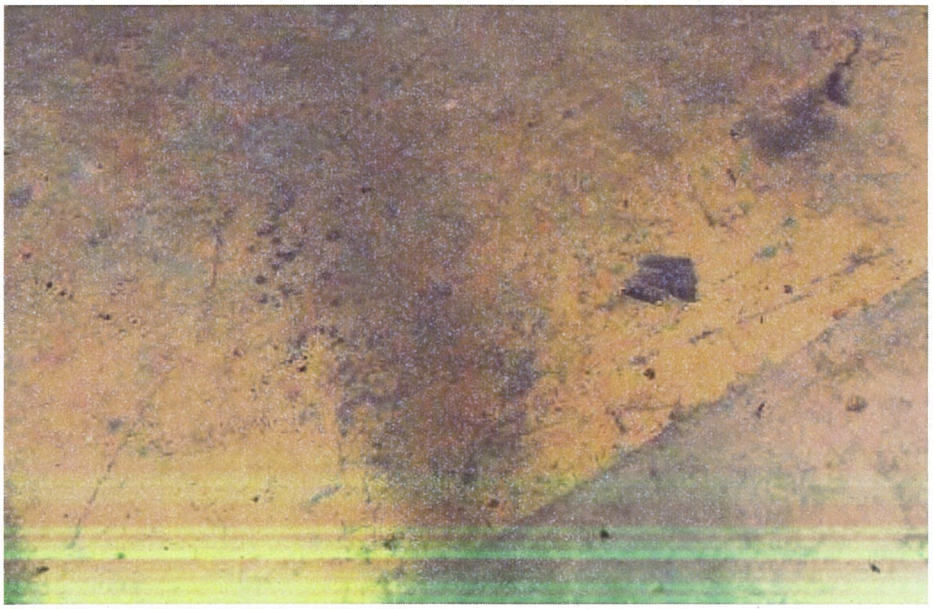


Photograph 15:

Non-asbestos grey air duct mastic (sample A2B)

Photograph 16:

Non-asbestos drywall joint compound observed (sample A3C).



Photograph 18:

Tan paint on concrete floor (sample AL1)

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