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Prepared for:

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Technical Specifications Issued for Tender

University of Guelph
Building #046 Renovations
Project No. 504034

Volume 3 – Divisions 20-26
Mechanical and Electrical Specifications

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

END OF SECTION

PART 1 - GENERAL

1.1 DOCUMENTS

.1 The contact documents are complementary, what is required by any one shall be as binding as if required by all. Specification sections and drawings cannot be read in isolation and it shall be the responsibility of the contractor and suppliers to ensure they have sufficient information to provide specified material and services as required by the complete contract documents

.2 These specifications are an integral part of the Contract Documents. Refer to other Sections to ensure a completed operational product and fully coordinated standard of work.

.3 Definitions:

.1 "Provide" means to "supply and install".

.2 "Concealed" means within chase, furred space, shaft, or hung ceiling.

.3 "Exposed" means "not concealed" as defined herein.

.4 “Demolish” means to “remove from site and depose of in an appropriate manner”.

.4 Conform to Canadian Metric Practice Guide CSA CAN3- 234.1.

.5 Provide all required adapters between "metric" and "Imperial" installations.

.6 Metric descriptions in this Division are nominal equivalents of Imperial values.

.7 “NPS” refers to Nominal Pipe Size and is the ASME B36 designation for various standard pipe sizes.

.8 Drawings do not indicate exact architectural, structural or electrical features. Examine drawings prior to fabricating and installing work to ensure no interference exists. Report conflict with work to Consultant before proceeding.

.9 Drawings show general design and arrangement of mechanical system installation, and are diagrammatic in some details. Coordinate all drawings and with all trades for complete operational system.

.10 Do not scale drawings to order material. Take field measurements before ordering materials and make material conform to site conditions.

1.2 SEPARATE PRICING

.1 The contractor shall provide pricing with the submission of their tender for the removal from the contract of the following items.

.2 The contractor within the bid shall identify separate pricing as follows;

.1 Demolition of the digester system as identified on drawing DM16. Including all tanks, pumps, and piping.

.2 Demolition and replace of all above grade storm piping, including insulation and concealment of the piping

1.3 COOPERATION WITH OTHER TRADES

.1 Review all contract documents, including those of the other trades, and coordinate with work of other Divisions and trades.

.2 Cooperate fully with Divisions 21, 22, 23, 25 and Division's 26 and 27 prior to installation to lay out location of ducts, diffusers, piping, lighting fixtures and other mechanical and electrical components in all areas.

.3 Report areas of conflict immediately to Consultant for comment. Do not continue work until corrective measures are prescribed.

.4 Locate distribution systems, access doors, equipment and materials for maximum useable space to satisfaction of Consultant.

1.4 CONTRACTOR COORDINATION SUBMITTALS

.1 This Contractor shall prepare and submit Interference and Coordination drawings for the following spaces / floor plans:

- .1 Mechanical Penthouse
- .2 Mechanical Rooms
- .3 Ground and Second Floors, for all services in ceiling spaces

.2 These coordination drawings shall represent:

- .1 The available space including all relevant structural and architectural components. The contractor shall review existing conditions and take dimensions as required to prepare the coordination submission. The contractor shall also coordinate the installation of new structural elements.
- .2 All purchased / ordered equipment dimensions.
- .3 Coordinate the installations of this trade as well as all divisions.
- .4 Coordinate the installation of all Div 22 plumbing piping (including insulation), Div 23 equipment, ductwork and piping (including insulation), Div 25 Controls wiring, Div 26 Lighting and power wiring, Div 27 communication wiring including cable tray installation.
- .5 The contractor shall coordinate the hanging and support of work, and utilize common support methods where possible.
- .6 The contractor shall complete these co ordination drawings from field measurements completed post demolition work.

.2 These drawings shall be submitted in both AutoCAD format and printed PDF, for Consultant for

1.5 CONTRACTOR REQUESTS FOR INFORMATION

.1 The Contractor may, after exercising due diligence to locate required information, request from the Consultant clarification or interpretation of the requirements of the Contract Documents. The Consultant shall, with reasonable promptness, respond to the Contractor's requests for clarification or interpretation. However, if the information requested by the Contractor is apparent from field observations, is contained in the Contract Documents or is reasonably inferable from them, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the Additional Services required to provide such information.

1.6 CODES AND BYLAWS PERMITS AND FEES

.1 Comply with all Codes and By-laws relating to system and equipment installations. Provide certificates to verify that the work installed conforms to the laws and regulations of all authorities having jurisdiction.

.2 Give all necessary notice, obtain all permits and pay all fees in order that the work specified herein may be completed.

.3 Coordinate with all other contractors prior to tender submission the application and payment, for all required building permit and inspection fees. The costs for these regulatory requirements shall be borne by this contract.

.4 Employ all sub-consultants or testing agencies required for completion of the work specified herein may be completed and properly verified.

1.7 TSSA CERTIFICATION

.1 It will be the responsibility of this Contractor to apply for and pay for any inspections required to achieve a TSSA certification.

.2 Prior to ordering of equipment, contractor will ensure the equipment has the required CRN number if required.

.3 The Contractor to determine the requirements of the TSSA inspector prior to installation and install the systems to meet the requirements of the TSSA inspector.

1.8 FIRE STOPPING

.1 Reference Section 07 84 00 – Fire Stopping.

.2 All fire stopping to be performed by a single certified contractor.

.3 This contractor will coordinate the construction of all openings through fire rated assemblies with the fire stopping contractor.

1.9 COMMISSIONING

.1 Reference Section 01 91 01 – Commissioning.

.2 The Contractor to make themselves, their subcontractors and their suppliers aware of the commissioning requirements for this project.

.3 The Contractor shall work with the designated commissioning agent to achieve a completely commissioned system. The contractor shall provide all material and labour to achieve the project commissioning objectives as specified.

1.10 COMPONENT AND SYSTEM TESTS

.1 Perform systematic check, test components in all systems and ensure that each system functions correctly before commencing balancing work.

.2 Provide all primary elements, test wells, balancing dampers, balancing valves and parts that are required for testing and balancing.

.3 Provide isolation valves on all instrumentation and on vents and other devices that require isolation during testing due to high pressures.

.4 Record all checks and tests. Manufacturer or supplier of the component tested to provide signed confirmation that installation is in accordance with their written recommendation. Contractor to countersign, identify system and component status with System Check Lists.

.5 Equipment and System start up documentation shall include but not be limited to the verification of the following;

- .1 Check alignment of all drives and end clearance on couplings.
- .2 Check seals on pumps and packing on valves.
- .3 Clean hydronic systems and fill with heat transfer fluid.
- .4 Verify rotation of electric motors and ratings of overload heaters.
- .5 Verify that control, interlock and power wiring are correct.
- .6 Complete lubrication of equipment.
- .7 Complete filter installation.
- .8 Adjust rotating equipment alignment and belt drive tension.
- .9 Check safety and operating control set points and automatic control sequences with design requirements.
- .10 Clean-up installation and temporary coverings, remove stickers and tags.
- .11 Touch-up painted finishes where damaged.
- .12 Complete equipment and piping identification work with valve tags, schedules and piping identification system.
- .13 Comb out fins on extended surface heat transfer coils where damaged.
- .14 Implement water treatment program with initial quality test of fluids in systems and domestic water supply, check chemical feeder equipment, and instruct chemical supplier in desired results.
- .15 Perform operational check of systems in conjunction with Control Contractor and Electrical Contractor representatives.

1.11 TEMPORARY AND TRIAL USE

.1 Obtain written permission from Consultant to use and test permanent equipment and systems prior to Substantial Performance.

.2 Trail usage may be required of equipment and systems for test purposes prior to acceptance. Provide labour, material and instruments required for testing. Rectify incomplete work immediately prior to acceptance

.3 Protect equipment and system openings from dirt, dust and other foreign materials during temporary usage.

.4 Warranty, including duration and commencement date, not to be affected by start-up date of equipment.

.5 Rectify deficiencies and complete all work before submitting request for Substantial Performance inspection.

1.12 PROJECT SCHEDULE

.1 Phase work in accordance with Division 1.

.2 Provide Consultant with Material Delivery Schedule and preliminary project construction schedule milestones within three (3) weeks of executing the agreement.

1.13 PROGRESS PAYMENTS

.1 Mechanical Progress Payment requests are to separately identify labour and material costs on a system-by-system basis. Each line item on the progress payment shall not exceed 10% of the total mechanical contract value.

.2 As a minimum, the following shall be separately identified and listed as a separate line item on the progress draw:

- .1 Mobilization, shop drawings, etc..
- .2 Commissioning.
- .3 Testing, adjusting, and balancing.
- .4 Identification.
- .5 All working below grade.
- .6 Close-out documentation.

.3 Payment for equipment: maximum of 90% of labour and material until the successful completion of the following:

- .1 Equipment manufacturer's start up tests.
- .2 Final testing and balancing.
- .3 Commissioning verification of proper (fully automatic) operation.
- .4 Equipment manufacturer's approval of installation and operation.

.4 Payment for control system: maximum 90% of labour and material until the successful completion of the following:

- .1 Commissioning verification of proper (fully automatic) operation and performance under all load conditions (part load, seasonal).
- .2 Operational review of the control system by the Consultant.

1.14 CONTRACTOR QUALITY ASSURANCE PROGRAM

.1 Contractor is solely responsible for the control, charge and supervision of construction means, methods, techniques, sequences and procedures, and for safety precautions and programs required in connection with the work.

.2 Contractor is solely responsible for the discovery and correction of deficiencies, errors and omissions in the execution and performance of the work and for the preparation of submissions (shop drawings, reports, etc.) relating to the work.

.3 Contractor is solely responsible for providing the appropriate quality assurance program to ensure that the work is carried out and performs in accordance with the Contract Documents, industry standards and relevant codes and legislation. Contractor Quality Assurance Program to ensure:

.1 The use of qualified tradesmen, experts and professionals with the level of skill and experience required for the proper execution and performance of the work.

.2 The level of direction, supervision and inspection required for the proper execution and performance of the work.

.3 The level of coordination between trades, field conditions, material requirements and product requirements required for the proper execution and performance of the work.

.4 The level of management required for the quality assurance program to operate effectively so that deficiencies, errors and omissions in the work are identified by the Contractor on a continuous basis and that corrective action is carried out promptly.

.5 The level of management and communication required for the status of the work to be properly monitored and reported to the Consultant.

.4 Field review (observations) of the work by the Consultant is not to be considered part of the Contractor Quality Assurance Program.

.5 The review of Contractor prepared submissions (shop drawings, reports, etc.) by the Consultant is not to be considered part of the Contractor Quality Assurance Program.

1.15 CONTRACTOR STATUS REPORTS

.1 Contractor is to submit a status report on a monthly basis, outlining the status of the following aspects of the work for each mechanical system. This is integral and supplementary to the requirements of commissioning.

.1 Distribution Systems:

.1 Installation Inspections.

.2 Integrity (Pressure, Leakage) Tests.

.3 Support System Inspection and Certification (by Contractor's Engineer).

.4 Inspections by Authorities having Jurisdiction (Municipal, Provincial).

.2 Equipment:

.1 Installation Inspections.

.2 Manufacturer Installation Acceptance.

.3 Start-up Inspections.

.4 Manufacturer Start-up Acceptance;

.5 Support System Inspection and Certification (by Contractor's Engineer).

.3 Balancing and Testing:

.1 Balancing Device Installation Inspection and Approval (by Contractor's Balancing Specialist).

.2 Preliminary Balancing of Equipment.

.3 Equipment Capacity Tests.

.4 Preliminary Balancing of Distribution Systems.

.5 Final Balancing of Equipment.

.6 Final Balancing of Distribution Systems.

.4 .Commissioning and Performance Verification:
  .1 Control Device Operation Verification.
  .2 Normal Operation Verification (part load, full load, seasonal).
  .3 Upset Condition Operation Verification (safety devices, equipment failure).
  .4 Failure Condition Operation (power failure, emergency power, control failure).

1.16 WARRANTIES

.1 Contractor to provide all labour and material to promptly correct defects or deficiencies in the work and the performance of the work, which appear prior to and during the one year Warranty period. Warranty is to include complete labour and material Product warranties for all Products included in the work.

.2 Warranty period for the corrected work is to be extended for an additional year following the correction of defects and deficiencies in the work carried out in the initial warranty period.

1.17 MECHANICAL SUBMITTALS

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

.2 Shop drawings to show mounting arrangements and operating and maintenance clearances.

.3 Shop drawings and product to include:
  .1 Detailed drawings of bases, supports, and anchor bolts.
  .2 Acoustic sound power data, where applicable.
  .3 Points of operation on performance curves.
  .4 Manufacturer certification of current equipment production.
  .5 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: provide a "Shop Drawing Submittal Title Sheet" and identify specification section and paragraph number.

.5 Closeout Submittals:
  .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection.
  .3 Operation data to include:
    .1 Control schematics for all systems, including environmental controls.
    .2 Description of systems and respective controls.
    .3 Description of operation of systems at various loads, with reset schedules and seasonal variances.
    .4 Operation instructions for systems and components.
    .5 Description of actions to be taken in event of equipment failure.
    .6 Valve schedule and flow diagram.
    .7 Colour coding chart.

.4 Maintenance data to include:
  .1 Servicing, maintenance, operation and trouble-shooting instructions for all 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 set 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 Division 23 - Testing, Adjusting and Balancing for HVAC.

.6 Approvals:
  .1 Submit two copies of draft Operation and Maintenance Manual to Consultant for review. Submission of individual data will not be accepted.
  .2 Make changes as required and re-submit when completed.

.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 This Contractor shall maintain, on site, a complete set of the contract documents. This contractor shall mark changes as work progresses and as changes occur. Include control systems and low voltage control wiring.
  .2 Use different colour waterproof ink for each service.
  .3 Make available as requested for reference purposes and inspection.
  .4 Upon request deliver the site record drawings to a local print shop so that colour copies of the site record drawings can be produced.

.9 Record drawings:
  .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of record drawings.
  .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  .3 Submit to Consultant for review and make corrections as directed.
  .4 Perform testing, adjusting and balancing, as specified in Division 23, for HVAC utilizing the record drawings.
  .5 Submit completed record drawings with Operating and Maintenance Manuals.
  .6 Submit copies of record drawings for inclusion in final TAB report.
  .7 Record Drawings should provide information such as:
    .1 Record and identify all revisions made to contract drawings and reference fabrication drawings included.
    .2 Record locations of primary isolation valves for emergency isolation of systems.
    .3 Record locations of concealed components of mechanical and electrical services.
    .4 Record inverts of underground piping at building entry/exit and below floor slab at each branch and riser base.

1.18 MAINTENANCE

.1 Furnish spare parts as follows:

.1 One set of packing for each pump.

.2 One filter cartridge or set of filter media for each filter or filter bank as well as final operating set.

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

1.19 INSTRUCTION OF OPERATING STAFF

.1 Provide trained personnel to instruct operating staff in maintenance, adjustment and operation of mechanical equipment.

.2 Provide instruction during regular work hours for a minimum 3 full days prior to acceptance and turnover to operating staff. See individual specification sections for additional training requirements.

.3 Notify Consultant of instruction period and await written notice to proceed. Submit a detailed agenda of training activities identifying presenter and time frame for each type of equipment and system.

.4 Utilize the Operating and Maintenance Manual and updated record drawings for instruction purposes.

.5 Instruct staff on changes made under terms of warranty or of modifications to equipment.

1.20 INTERRUPTION OF EXISTING SERVICES

.1 Arrange schedule and perform work with minimum disturbance to existing facilities and services. Provide all overtime work required to minimize interruption of existing facilities and services.

.2 Notify Consultant in writing at least 48 hours in advance of planned interruption to existing service.

.3 Drawings approximately indicate known existing underground facilities. Avoid damage to existing services. Bear cost of repairs and replacements.

.4 Immediately advise Consultant if services are not as indicated or when unknown services are encountered and await instructions.

PART 2 – PRODUCTS

2.1 ARCHITECTURAL SERVICE ACCESS DOORS

.1 Coordinate with architectural drawings for locations and wall and ceiling finishes.

.2 Size: 300 mm x 300 mm or larger, as required to properly service concealed equipment and devices

.1 Minimum 300x300 for hand access.

.2 Minimum 450x450 for arm access.

.3 600x600 for any other access.

.3 Material: 2.5 mm thick, flush type steel door, frame and anchor straps, with concealed hinge.

.4 Fire rated where penetrating fire rated assemblies.

.5 Finish: to suit painted gypsum, plaster or suspended tile ceiling

.6 Coordinate the products and supply of access doors with Div 9.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Location of access doors to be located by responsible division. Access doors to be installed by drywall or block installer.

.2 Locate access doors to serve concealed equipment, fire dampers, expansion joints, valves, cleanouts and any other equipment requiring accessibility for operation and maintenance.

.3 Be prepared to demonstrate accessibility of devices through access doors. Relocate or enlarge access doors to suit conditions.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 23 - Interior Painting.

.2 Prime and touch up marred finished paintwork to match original.

.3 Restore finishes which have been damaged to new condition.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

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

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

3.4 SYSTEM AND EQUIPMENT CLEANING AND OPERATIONAL STATUS

.1 Do not operate equipment until systems are clean.

.2 Remove all debris from inside mechanical equipment, ductwork and piping systems.

.3 Vacuum clean inside duct systems.

.4 Replace construction strainers and filters with operational strainers and filters.

.5 After completing tests, replacement and repair, flush water systems thoroughly with water to remove sediment.

3.5 PROTECTION OF WORK

.1 Protect all finished and unfinished work from damage. Protect bearings, seals, glands, shafts of rotating equipment. Cover floors and other work with tarpaulins where required.

.2 Repair damage caused to surfaces of building without cost to Owner and to satisfaction of Consultant.

.3 Be responsible for condition of all materials and equipment supplied and/or installed. Provide protection prior to, during and after installation until takeover by Owner.

.4 Protect floor drains, pipe and duct openings, filters, elements and materials against dirt and abuse during construction.

3.6 DEMONSTRATION

.1 Consultant 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, record drawings, and audio visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 Provide identification system for piping, valves, ductwork, and equipment.

.2 Identification to consist of colour codes, valve tags, equipment and system nameplates, lettered identification, and schedules.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 Canadian Gas Association (CGA):
- .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.

.3 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
- .2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.4 ANSI:
- .1 ANSI A13-1 Pipe Marking Standards.

.5 National Fire Protection Association (NFPA):
- .1 NFPA 13-2007, Standard for the Installation of Sprinkler Systems.
- .2 NFPA 14-2007, Standard for the Installation of Standpipe and Hose Systems.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 - Submittals.

.2 Product Data:
- .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data shall include all relevant information to confirm the specifications have been met.

.3 Legends: Submit list of all identification methods and means for approval prior to identification installation. List should identify system, background colour and lettering colour.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Provide metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers to be raised or recessed.

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

.4 Ensure all equipment nameplates have not been concealed by insulation and are visible post construction.

2.2 PRIMARY COLOURS GENERAL

.1 Colours: In accordance with Canadian General Standards Board Standards:
- .1 Hazardous: red letters, white background.
- .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 For primary identification of systems utilize the following colours.

System Type	Background Primary Colour	Lettering / Flow Arrow Colour
Inherently Hazardous Materials including: - Flammable and Explosive Fluids - Chemically Toxic or Corrosive Fluids - Extreme Temperature or Pressure - Radioactive	Yellow	Black
Flammable (Natural Gas / Propane)	Yellow	Black
Combustible Contents	Brown	White
Toxic / Corrosive Contents	Orange	Black
Water Piping (Plumbing Systems)	Green	White
Fire Quenching Fire Protection Systems	Red	White
Heating and Cooling Systems	Yellow	Black

2.3 VISIBILITY REQUIREMENTS

.1 Markers shall be located so that they are readily visible to personnel from the point of normal approach and instantly inform you about contents, direction of flow and whether hazardous or safe.

.2 Size of lettering shall conform to the following table.

Pipe or Duct Size (Outside including Covering)	Height of Letters
NPS ¾ thru 1 ¼ (¾"Ø thru 1 ¼"Ø)	12.5 mm (½")
NPS 1½ thru 2 (1½ "Ø thru 2"Ø)	20 mm (¾")
NPS 2½ thru 6 (2½ "Ø thru 6"Ø)	32 mm (1¼")
NPS 8 thru 10 (8"Ø thru 10"Ø)	65 mm (2½")
NPS 12 and over (12"Ø and over)	75 mm (3")

.3 Length of identification markers shall be minimum 300 mm (12"), and as required for lettering.

2.4 CONTRACTOR'S EQUIPMENT IDENTIFICATION

.1 Individual equipment shall be identified with nameplates, by the identification assigned on the Drawings, Schedules, and specifications.

.2 Identification to include equipment type and number, service, area or zone of building served.

.3 The identification name plate shall be located adjacent manufacturer's nameplate or in a conspicuous location on the equipment. Use isolating standoffs when plates mounted on hot surface.

.4 In addition to the nameplates required for the equipment, auxiliary equipment such as starters and control panels shall be identified with similar nameplates.

.5 Construction:

.1 Cold Surfaces: 3 mm thick laminated plastic, with square corners, letters accurately aligned and machine engraved into core.

.2 Hot Surfaces: 3 mm thick white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved.

2.5 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 Refer to Client Identification Standards.

2.6 PIPING SYSTEMS GOVERENED BY CODES

.1 The following piping systems require the minimum identification in accordance with the codes identified.

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

.2 Sprinklers: to NFPA 13.

.2 These codes shall be adhered to, and additionally these systems shall be identified as per the requirements of this section.

2.7 PIPING SYSTEMS IDENTIFICATION

.1 Pipe identifications systems shall be a manufactured system consisting of vinyl markers which will adhere to the piping or pipe covering. Identification system shall be suitable for a surface temperature of -40°C (-40°F) to 60°C (140°F).

.2 Identification Tape: vinyl, pressure sensitive, self-adhesive pipe markers adhered to pipe and or coating. Marker ends should be banded with self-adhesive tape with directional flow arrows to indicate pipe content flow direction.

.3 Snap-on Pipe Markers: vinyl markers minimum 0.55 mm (0.02”) thick, pre-tensioned, cylindrically coiled printed plastic sheets.

.4 Strap-on Pipe Markers: vinyl markers minimum 0.55 mm (0.02”) thick, flat printed plastic sheets with strap holes.

2.8 VALVE IDENTIFICATION TAGS

.1 Prepare valve list of all valves meeting the following criteria:
- .1 Primary System Isolation Valves;
- .2 Zone / Area Isolation Valves;
- .3 Riser Isolation Valves;
- .4 Any valve NOT visible from the equipment being serviced.

.2 Valve list shall indicate location and purpose of valve. If isolation valve for a recirculation closed system, the appropriate return isolation valve shall be identified.

.3 Provide valves with fire and heat resistant laminated plastic numbered tags 40 mm (1½") diameter with 12 mm (½") engraved code. Tag to be in system primary colour with contrasting coloured numbers.

.4 List tag schedule designating number, service, function, and location of each tagged item. Identify normal operating position of valves.

.5 Provide one (1) copy in plastic cover for each Operation and Maintenance.

.6 Provide copy of valve schedule, mounted under glass in black wooden frame and mounted in the mechanical room and the penthouse.

2.9 DUCT SYSTEMS IDENTIFICATION

.1 Provide 75 mm (3”) high black stenciled letters, reading: Fresh Air, Supply, Return, Exhaust Air, etc. with directional flow arrow for all ducts and ducts with insulation.

.2 Identify fire dampers and access doors on the downstream side.

2.10 CONTROL SYSTEM IDENTIFICATION

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

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

2.11 CEILING AND ACCESS PANEL IDENTIFICATION

.1 Ceiling grids and access panels shall be identified with the following identification for mechanical services:

.1 Red Dot - Fire Damper

.2 Blue Dot - Heating & Cooling (coil, valves, etc.)

.3 Yellow Dot - VAV

.4 Green Dot - Potable & Non-Potable Water

2.12 JLR SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.1 Identification Systems: Brady.

PART 3 - EXECUTION

3.1 GENERAL

.1 Prior to installation ensure that surfaces to be covered are clean and dry, and any insulation system has been completed.

.2 Pressure-sensitive tape shall be applied with moving pressure using a squeegee or other appropriate sealing tool.

.3 Locate markers and classifying colours to be visible from floor or platform. Where concealed above ceiling, identify marker location with circular adhesive marker on ceiling grid at partition walls. Identification easily and accurately readable from usual operating areas and from access points.

.4 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.

.5 Do not exceed 15 m (50') between identification.

.6 Identify piping / ductwork on both sides of obscuring equipment.

.7 Identify both sides where piping / ductwork passes through walls, partitions and floors or is concealed in chase, gallery or other confined space.

.8 Identify systems at least once in each small room through which piping or ductwork passes.

.9 Identify piping at all major manual and automatic valves immediately upstream of valves. Identify branch, equipment or building served after such valve.

.10 Identify ducts at all dampers. Identify branch, equipment or building served after such damper.

.11 Identify services in full except in cases of limited space. Avoid single letter abbreviations.

.12 Check colour classification in table with respect to environment, location and service.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 IDENTIFICATION CHART

.1 Refer to the following chart for system identification requirements.

Service	Background Colour	Lettering Colour	Lettering	Painted Entire Length
Domestic Cold Water	Green	White	DOM COLD WATER	
Domestic Hot Water	Green	White	DOM HOT WATER	
Domestic Hot Water Recirculation	Green	White	DOM HOT WATER RECIRC	
Non-Potable Water - Cold	Green	White	NON-POTABLE COLD WATER	
Non-Potable Water - Hot	Green	White	NON-POTABLE HOT WATER	
Sanitary	Green	White	SANITARY	
Storm	Green	White	STORM	
Plumbing Vent	Green	White	PLUMBING VENT	
Compressed Air	Green	White	AIR	
Fire Wet Sprinkler System	Red	White	FIRE SPRINKLER	
Heating Water Supply	Yellow	Black	HEATING WATER SUPPLY	
Heating Water Return	Yellow	Black	HEATING WATER RETURN	
Heating Glycol Supply	Yellow	Black	HEATING GLYCOL SUPPLY	
Heating Glycol Return	Yellow	Black	HEATING GLYCOL SUPPLY	
Steam	Yellow	Black	XX PSI STEAM	
Steam Condensate	Yellow	Black	STEAM CONDENSATE	
Chilled Water Supply	Green	White	COOLING WATER SUPPLY	
Chilled Water Return	Green	White	COOLING WATER RETURN	
Supply Air Duct	White	Black	SUPPLY AIR DUCT	
Return Air Duct	White	Black	RETURN AIR DUCT	
Exhaust Air Duct	White	Black	EXHAUST AIR DUCT	
Outside Air Duct	White	Black	OUTSIDE AIR DUCT	

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 Provide the standards with which all pipe shall be installed. These standards shall be inclusive of all pipe systems, valves and accessories.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 Canadian General Standards Board (CGSB):
.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.3 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.

.4 National Fire Code of Canada (NFCC 2005).

1.3 MAINTENANCE REQUIREMENTS

.1 The Contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 GENERAL

.1 Install pipes parallel and close to the building structure.

.2 Locate groups of pipes parallel to each other and spaced at a distance to permit service access for valves or other equipment located above.

.3 Pipe routing, connections and take-offs to follow building lines.

.4 Provide swing joints, offsets and prefabricated expansion joints to accommodate pipe expansion or contraction due to temperature change.

.5 Provide three (3) elbow swing joints on each branch connection to main at points of expansion or contraction due to temperature change.

.6 Coordinate piping and pipe supporting elements with building architectural, structural, and electrical systems to ensure proper installation and access for maintenance and service.

.7 Coordinate pipe supporting elements with other mechanical systems.

.8 Provide all pipe supporting elements as necessary to ensure proper support under all operating conditions and in accordance with relevant standards and the constraints and requirements of the piping system manufacturer (pipe, fittings, valves, equipment, etc.).

.9 Each pipe support to be field adjustable under full load conditions.

.10 Re-adjust all pipe support elements after initial installation as required to suit final operating conditions.

.11 Do not conceal piping and pipe supporting elements before the completion of the Contractor's quality assurance inspection and testing and approval of local authorities having jurisdiction.

3.2 PIPE INSTALLATION

.1 Screwed fittings jointed with Teflon tape.

.2 Protect openings against entry of foreign material.

.3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.4 Assemble piping using fittings manufactured to ANSI standards.

.5 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

.6 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.8 Install concealed pipework to minimize furring space, maximize headroom conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install pipe to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible.

.12 Ream pipes and remove scale and other foreign material before assembly.

.13 Provide for thermal expansion as indicated.

3.3 VALVE INSTALLATION

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Valves accessible for maintenance without removing adjacent piping.

.4 Use gate, ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.

.5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.

.6 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

3.4 PIPE SUPPORT

.1 The design of pipe supporting elements is dependent on Contractor controlled methods of installation and the physical characteristics, limitations and operating characteristics of the piping system.

.2 Contractor controlled methods of installation include the physical location of the pipe (distance to support structure), method of support (hanger, trapeze, etc.), attachment location (roof structure, column, interior wall, etc.), attachment method (cast in place, expansion inserts, structural bridging, clamping, etc.) and piping systems being supported (single, multiple, etc.).

.3 Provide pipe supporting elements to properly support piping system (pipe, fittings, valves, equipment, etc.) such that the piping system and pipe supporting elements are protected from excessive stress and distortion.

.4 Pipe supporting elements consist of hangers which support from above, supports which bear load from below, restraints, anchors, and guides which limit or direct movement as well as support loads and attachments between support elements and the structure.

.5 Design the pipe supporting elements to carry the sum of all concurrently acting static and dynamic loads, including the following:

- .1 Dead weight of pipe, fittings, valves, insulation, inline equipment, hanger system, contents and other pipes (if supported from the line under consideration).
- .2 Live weight of contents.
- .3 Weight of test fluid, when greater than normal fluid (not considered concurrent with occasional loads).
- .4 Occasional loads such as ice, wind, and earthquake loads.
- .5 Forces imposed by thermal expansion and contraction of pipe bends and loops.
- .6 Frictional, spring and pressure thrust forces imposed by expansion joints in the system.
- .7 Frictional forces of guides and supports.
- .8 Forces due to internal pressure.
- .9 Forces due to changes in direction of flow at bends and elbows.
- .10 Forces due to operation of safety, relief, and stop valves.

.6 Coordinate support system design and installation with the requirements and constraints of the piping system manufacturer (pipe, fittings, valves, equipment, etc.).

.7 Coordinate support system design with the requirements and constraints of the connected equipment, structure, vibration isolation systems and seismic restraint systems.

3.5 HANGERS

.1 Hangers to be capable of field adjustment while supporting the load.

.2 Turnbuckles and adjusting nuts are to have full thread engagement and suitable locking devices.

.3 Where piping moves horizontally due to thermal expansion/contraction, hanger components to allow for swing and travelling devices (rolling or slip supports) and restraints are to be provided as required to limit hanger swing angle to less than 4°.

.4 Where trapeze supports are provided to reduce hanger attachments to the structure, individual hangers or base supports are to be provided for each pipe attached to the trapeze to allow for individual adjustment and support to suit requirements for sloping, horizontal movement and vertical movement.

3.6 SUPPORT SPACING

.1 Support spacing to limit the stresses in the piping to be less than the allowable stress when determined on the basis of a support span twice that of the actual span.

.2 Support spacing to limit the deflection to less than the smaller of 50 mm or 10% of the nominal diameter of the pipe, based on the weight of the empty pipe, insulation and other dead loads.

.3 Support spacing varies with pipe material (steel, cast iron, glass, plastic, etc.), type of fitting (screwed, welded, flanged, soldered, brazed, thermoplastic welded, mechanical and proprietary joints, etc.), media contained (fluid, gas), ambient temperature and temperature of media contained.

.4 Provide support spacing in accordance with MSS SP-69, relevant ASME standards and piping/fitting manufacturer's standards.

3.7 ANCHORS, GUIDES AND RESTRAINTS

.1 Provide anchors, guides, pivots and other restraints required to secure piping (fittings, expansion joints, elbows, etc.) while withstanding thrusts, moments and other imposed loads.

.2 Where Z-bends, U-bends or pipe loop expansion arrangements are used, provide anchors and guides to direct movement along axis of joint. Guide spacing to take into consideration the column buckling strength of the pipe.

3.8 PIPE ATTACHMENTS

.1 Provide non-integral type pipe attachments including clamps, slings, cradles, saddles, straps, clevises and rollers for support of horizontal piping.

.2 Non-integral pipe attachments (clamps) for vertical pipes are to incorporate shear lugs or be welded to the pipe to prevent slippage.

.3 Attachments for piping systems which require movement due to thermal expansion are to include rolling or sliding supports. The support is to include for free movement of the pipe or the imposed loads and friction forces of the supports.

.4 Provide protective surfaces (pads, cushions, shields, etc.) on supports for piping which requires protection against contact damage in accordance with the pipe manufacturer's requirements. Examples: glass, plastic, fiberglass piping.

.5 Pipe attachment material to be compatible with the pipe material or be suitably isolated to prevent corrosion due to contact of dissimilar metals.

.6 Pipe attachments for insulated pipe not to pierce insulation and to be provided with shields and/or insulated saddles to prevent insulation damage from the loads transmitted to the pipe support.

.7 Where welded integral type attachments are required (ears, shoes, lugs, cylindrical attachments, rings, and skirts, etc.) for multi-axial type loading, materials to be compatible with piping and strength to be adequate for all expected loads.

3.9 CONNECTIONS TO BUILDING STRUCTURE

.1 Spacing, location and loading of individual attachments and all piping system attachments not to exceed capacity of structure.

.2 Attachments to concrete floor to be at least 400 mm from edge of slab.

.3 Attachments to concrete floor to be cast in place inserts or expansion studs and anchors. Explosive actuated fasteners not permitted.

.4 Attachments to composite metal roof deck not to interfere with composite behaviour of roof deck structure.

.5 Attachments to metal roof deck not permitted.

.6 Locate connections to open web steel joists at panel points.

.7 Attachments to steel structure to be bolted type connections.

.8 Beam attachments to provide concentric support on both sides of beam.

.9 Maximum loads on attachments to concrete not to exceed one-fifth of the ultimate strength of the attachment as determined by manufacturer's tests. Install attachments in accordance with manufacturer's requirements.

3.10 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.2 Material: schedule 40 black steel pipe.

.3 Construction: foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

.4 Sizes: 12 mm (1/2”) minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:
- .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
- .2 Other floors: terminate 25 mm above finished floor.
- .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:
- .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
- .2 Elsewhere: Provide space for fire stopping. Maintain fire rating integrity.
- .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

.7 Ensure no contact between copper pipe or tube and sleeve.

3.11 FIRE STOPPING

.1 All fire stopping shall be the work of one contractor. Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation Division 07 Standards.

.2 Uninsulated unheated pipes not subject to movement: no special preparation.

.3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fire stopping material or installation.

.4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.12 ESCHECHEONS

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

.2 Construction: one piece type with set screws. Polished chrome plated brass.

.3 Sizes: outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.13 CONNECTIONS TO EQUIPMENT

.1 Piping shall be independently supported from equipment. Weight of piping shall not be imposed upon connections to equipment.

.2 In accordance with manufacturer's instructions unless otherwise indicated.

.3 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.4 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

.5 Provide immediate elbows to clear path for coil removal for coils requiring removal.

3.14 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment and components.

3.15 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.

.4 Drain valves: NPS ½ (½"Ø) ball valves unless indicated otherwise, with hose end male thread, cap and chain.

3.16 AIR VENTS

.1 Install manual air vents at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

3.17 DI-ELECTRIC COUPLINGS

.1 General: compatible with system, to suit pressure rating of system.

.2 Locations: where dissimilar metals are joined.

.3 NPS 2½ (2½"Ø) and under: isolating unions or bronze valves.

.4 Over NPS 3 (3"Ø): isolating flanges.

3.18 PRESSURE TESTING

.1 Advise Consultant 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Consultant.

.6 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Consultant.

3.19 SYSTEM CLEANING

.1 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

.2 Replace construction screens on strainers with service screens.

3.20 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by Consultant.

.2 Request written approval 10 days minimum, prior to commencement of work.

.3 Be responsible for damage to existing plant by this work.

.4 Ensure daily clean-up of existing areas.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the requirements for piping support and hangers and equipment supports and bases.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 American Society of Mechanical Engineers (ASME):
- .1 ASME B31.1-07, Power Piping.

.3 ASTM International:
- .1 ASTM A 125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
- .2 ASTM A 307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .3 ASTM A 563-07a, Standard Specification for Carbon and Alloy Steel Nuts.

.4 Factory Mutual (FM).

.5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
- .1 MSS SP 58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
- .2 MSS SP 69-2003, Pipe Hangers and Supports - Selection and Application.
- .3 MSS SP 89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

.6 Underwriter's Laboratories of Canada (ULC).

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 - Submittals.

.2 Product Data:
- .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data shall include all relevant information to confirm the specifications have been met.
- .5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data shall identify all ancillary field installed devices and provide all information required for the co-ordination of the installation with other trades.
- .7 Product data shall include information as specified in Section 20 01 01 – Common Work Results – Mechanical Submittals unless modified with additional information required below.

.3 Refer to Section 20 05 48 - Vibration and Seismic Controls for Piping, Ducts and Equipment. When the piping and equipment support system is required to be seismically engineered, all product information and shop drawings related to this section shall be submitted as per the requirements of Section 20 05 48. Submit drawings stamped and signed by professional engineer licensed in Province of Ontario, Canada.

1.4 MAINTENANCE REQUIREMENTS

.1 The Contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP 58.

.2 Design Requirements:

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

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.

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

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

.5 Provide for vertical adjustments after erection and during commissioning.

.3 Hangers and supports subject to interior conditions with high humidity levels will be hot dipped galvanized.

.4 Hangers and supports subject to exterior conditions shall be hot dipped galvanized.

.5 Hangers and supports subject to corrosive conditions shall be epoxy coated.

.6 Hangers and supports in contact with copper pipe will be epoxy coated.

.7 Hangers and support utilized for insulated piping shall be selected (up sized) and installed to accommodate the insulation requirements of the pipe supported.

2.2 SEISMIC REQUIREMENTS

.1 Refer to Section 20 05 48 - Vibration and Seismic Controls for Piping, Ducts and Equipment for seismic requirements for this project.

2.3 PIPE HANGERS

.1 Adjustable Swivel Type Hanger:

.1 Application: Stationary Pipe (Copper and Steel), not insulated, NPS ½ (½”Ø) thru NPS 4 (4”Ø).

.2 Carbon steel construction.

.3 Finish meeting the conditional requirements.

.4 Hangers shall be UL listed and FM approved.

.2 Adjustable Clevis Hanger:

.1 Application: Stationary Pipe (Copper and Steel), insulated and not insulated, NPS ½ (½"Ø) thru NPS 24 (24"Ø).

.2 Carbon steel construction.

.3 Finish meeting the conditional requirements.

.4 Hangers shall be UL listed and FM approved.

.3 Adjustable Yoke, Pipe Roller Hanger:

.1 Application: Non-stationary for longitudinal movement, pipe (Copper and Steel), insulated and not insulated, NPS 2½ (2½ "Ø) thru NPS 24 (24"Ø).

.2 Carbon steel construction, cast iron roller.

.3 Finish meeting the conditional requirements.

.4 Trapeze Hanger Assemblies, Shop and Field Fabricated:

.1 Utilized for support of multiple pipes either for hanger attachment or support from beneath. Steel construction, shop or field fabricated meeting the requirements of ASME B31.1 and MSS SP 58.

.5 Steel Brackets Shop and Field Fabricated:

.1 Utilized for support of pipes from a wall, r for hanger attachment or support from beneath. Steel construction, shop or field fabricated meeting the requirements of ASME B31.1 and MSS SP 58.

.6 Hanger Rod: carbon steel threaded rod, size to suit load and application, material to MSS SP 58. Ensure that hanger rods are subject to tensile loading only.

.7 U-bolts: carbon steel to MSS SP 69 with 2 nuts at each end to ASTM A 563.

.8 Pipe Guides and Anchors:

.1 Carbon steel alignment guides for maintaining alignment of piping through its axial expansion and contraction cycles.

.2 Anchors shall be directly connected to the structure and prevent axial expansion at the anchor point.

.3 For all anchors and guides piping shall be installed to maintain maximum insulation values.

2.4 RISER CLAMPS

.1 Steel or Cast Iron Pipe: carbon steel. UL listed and FM approved complying with MSS-SP 58 and MSS-SP 69.

.2 Copper Pipe: carbon steel copper plated. UL listed and FM approved complying with MSS-SP 58 and MSS-SP 69.

.3 Bolts: to ASTM A 307.

.4 Nuts: to ASTM A 563.

2.5 INSULATION PROTECTION SHIELDS

.1 For cold insulated piping the hangers shall support from the exterior jacket and shall not penetrate the insulation or the insulation jacket / vapor barrier.

.2 For NPS ½ (½"Ø) thru NPS 4 (4"Ø) insulated pipe (any application) and standard insulation the pipe insulation shall be protected with a metal shield installed between the hanger and the insulation jacket. The shield shall be minimum 1.3 mm thick (18 ga.) and be installed centred on the pipe hanger and shall extend 150 mm either side of the hanger. The shield shall provide 180 degree protection of the insulation and be installed centred on the base of the pipe.

.3 For NPS 6 (6"Ø) pipe and greater insulated pipe, the insulation shall be protected with an insulation saddle. The saddle shall provide direct transfer of pipe loads to the pipe hanger without the insulation being compressed. The saddle shall be constructed from similar material as the pipe or be of a dielectric construction. The saddle shall be attached to the pipe and insulation shall be installed in the interstitial space. The saddle shall be installed centred on the pipe hanger and shall extend 100 mm either side of the hanger. The vapor barrier shall be installed around the pipe saddle.

.4 For all pipe installed with roller style hangers the insulation shall be protected with pipe saddles.

2.6 CONNECTIONS TO STRUCTURE

.1 All connections to new or existing structure shall be reviewed and coordinated with both Division 3 and Division 5.

.2 Attachment Structural Steel:

.1 Piping NPS 2 (2"Ø) maximum: malleable iron C-clamp with hardened steel cup point setscrew and locknut. UL listed and FM approved complying with MSS-SP 58 and MSS-SP 69.

.2 Piping NPS 2½ (2½"Ø) or greater: malleable iron beam clamp, eye rod, jaws and extension, tie rod, nuts and washers. UL listed and FM approved complying with MSS-SP 58 and MSS-SP 69.

.3 Rod: carbon steel threaded rod, size to suit loading applied. Complying with MSS-SP 58 and MSS-SP 69.

.3 Attachment to Concrete New Construction / New Concrete Pour:

.1 Prior to concrete pour install wedge style concrete inserts. Carbon steel construction with knock out plates and malleable iron nut. UL listed and FM approved complying with MSS-SP 58 and MSS-SP 69.

.4 Attachment to Existing Concrete:

.1 Concrete rod attachment plate. Carbon steel plate, welded eye rod, clevis plate, clevis pin and cotters with forged steel eye nut. UL listed and FM approved complying with MSS-SP 58 and MSS-SP 69.

.2 Bolting and attachment to existing concrete to Divisions 3 and 5 standards.

2.7 EQUIPMENT SUPPORTS PLATFORMS AND CATWALKS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

.2 For both manufactured, shop fabricated and field fabricated support systems, provide templates to ensure accurate location of anchor bolts.

2.8 HOUSEKEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 150 mm (6") larger than equipment; chamfer pad edges and corners.

.2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.9 JLR SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below.

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 E Myatt and Company Inc.

.2 Taylor Pipe Supports

PART 3 - EXECUTION

3.1 GENERAL

.1 Coordinate the installation with other divisions to ensure that the piping and equipment support systems are incorporated into the design and installation activities of those divisions.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

.1 Clevis plates:

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

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

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.3 Clamps on riser piping:

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

.4 Vibration Control Devices:

.1 Install on piping systems at pumps and as indicated.

3.4 HANGER SPACING

.1 Plumbing piping: to Ontario Plumbing Code and National Plumbing Code or to the authority having jurisdiction.

.2 Fire protection: to applicable NFPA fire code.

.3 Gas and fuel oil piping: up to NPS ¾ (¾"Ø): every 1.8 m.

.4 Copper piping: up to NPS ¾ (¾"Ø): every 1.5 m.

.5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.6 Within 300 mm (12") of each elbow.

Pipe Size	Steel Pipe Maximum Spacing	Copper Pipe Maximum Spacing
NPS ¾ (¾"Ø)	2.4M (8')	1.8M (6')
NPS 1 (1"Ø)	2.4M (8')	1.8M (6')
NPS 1¼ (1 ¼"Ø)	2.4M (8')	1.8M (6')
NPS 1½ (1 ½"Ø)	3.0M (10')	2.4M (8')
NPS 2 (2"Ø)	3.0M (10')	2.4M (8')
NPS 2½ (2 ½"Ø)	3.7M (12')	3.0M (10')
NPS 3 (3"Ø)	3.7M (12')	3.0M (10')
NPS 4 (4"Ø)	3.7M (12')	3.0M (10')
NPS 6 (6"Ø)	4.3M (14')	
NPS 8 (8"Ø)	4.3M (14')	
NPS 10 (10"Ø)	4.9M (16')	
NPS 12 (12"Ø)	4.9M (16')	
Pipework greater than NPS 12: to MSS SP 69		

3.5 HANGER INSTALLATION

.1 Install hanger so that rod is vertical under operating conditions.

.2 Adjust hangers to equalize load.

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

.4 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

3.6 ADJUSTMENT

.1 Adjust hangers and supports:
- .1 Ensure that rod is vertical under operating conditions.
- .2 Equalize loads.

.2 Adjustable clevis:
- .1 Tighten hanger load nut securely to ensure proper hanger performance.
- .2 Tighten upper nut after adjustment.

.3 C-clamps:
- .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:
- .1 Hammer jaw firmly against underside of beam.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section will define the design requirements for vibration isolation and seismic control systems. The contractor, or their agent will design these systems, and shop drawings will be submitted for the systems.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 National Building Code of Canada (NBC).

.3 Ontario Building Code.

.4 National Fire Protection Association (NFPA):

.1 NFPA 13, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14, Standard for the installation of Standpipe Systems.

.5 ASHRAE and SMACNA Standards for Seismic Restraint.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:

.1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data shall include all relevant information to confirm the specifications have been met.

.4 Equipment vibration control devices, seismic control devices and equipment bases are to be from one manufacturer.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer licensed in Province of Ontario, Canada.

.2 Provide detailed drawings of all seismic control measures for equipment piping, and ductwork.

.3 Contractor to provide all necessary data on equipment, pipe support and duct support requirements to the vibration and seismic control manufacturer, supplier, or design engineer.

.4 Shop drawings to be reviewed and approved by Contractor's Structural Engineer responsible for design of supports, anchors and restraints prior to submission. Shop Drawings to bear the signature of Contractor's Structural Engineer or be accompanied by a signed letter indicating his review and acceptance of the seismic design.

.5 Shop Drawings to include design stresses and loads imposed upon the structure and identify method of attachment.

1.4 QUALITY ASSURANCE

.1 Performance Requirements defined: Catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Vibration control measures to conform to latest edition of ASHRAE standards for vibration control and isolation.

1.5 DESIGN STANDARDS

.1 Refer to architectural and structural drawings for seismic requirements for this project prior to design and construction.

.2 Refer to the applicable building code for the Stainless Steel Mapped Horizontal Spectral Response Acceleration Factors.

.3 Refer to the architectural and structural drawings, for the importance factor to be applied to the design.

.4 Review and understand the structural drawings, construction methodology and related design information prior to preparing and design of the seismic restraint systems.

.5 No equipment, equipment supports or mounts to fail before failure of structure.

PART 2 – PRODUCTS

2.1 GENERAL

.1 The products identified below are specified as minimum standards of manufactured equipment to be utilized for vibration isolation.

.2 Static equipment: Anchor equipment to equipment supports. Anchor equipment supports to structure.

.3 Suspended equipment: Use one or more of following methods:

- .1 Install tight to structure.
- .2 Cross brace in every direction.
- .3 Brace back to structure.
- .4 Cable restraint system.
- .5 Cushioning action gentle and steady.

.4 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

2.2 METAL HOSE PIPING PUMP CONNECTORS

.1 Type 304 stainless steel, braided outer core and inner core with annular corrugation, rated for 2070 kPa (300 psi) operation.

.2 Provide with carbon steel flanged ends to ANSI B16.5 for piping NPS 2½ (2½") diameter and larger, screwed ends to ANSI B52.1 for piping NPS 2 (2") and smaller.

.3 Use minimum end to end dimension of 300 mm (12").

2.3 RUBBER PAD ISOLATORS

.1 Rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.4 NEOPRENE ISOLATORS

.1 Double deflection neoprene mountings and double deflection rails are recommended for minor equipment or basement locations only. This limitation on all rubberlike materials because of their relatively minor deflections.

.2 Neoprene mountings shall have a minimum static deflection of 9 mm (0.35”). All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang.

2.5 SPRING MOUNTS ISOLATORS

.1 Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 6 mm (¼”) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

.2 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.3 Open Spring: 6 mm (¼”) minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Restrained Open Spring: supported on bonded 6 mm (¼”) minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

2.6 NEOPRENE AND SPRING ISOLATED HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Hangers shall consist of rigid steel frame containing a minimum 32 mm (1¼") thick, Low Dynamic Stiffness (LDS) rubber element at the top and a steel spring seated in a steel washer reinforced LDS rubber cup on the bottom. The LDS rubber element and the cup shall have molded bushings projecting through the steel box. Spring and hanger lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

2.7 HORIZONTAL THRUST RESTRAINTS

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

2.8 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below.

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Senior Flexonics

.2 Metalflex Inc.

.3 Vibra-Sonic Control

PART 3 - EXECUTION

3.1 GENERAL

.1 Coordinate vibration isolation and seismic restraint with structural, architectural and electrical building systems.

3.2 MANUFACTURER'S INSTRUCTIONS

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This Section includes requirements for selective demolition and removal of plumbing, sanitation, sprinkler systems, heating, ventilation and air conditioning systems, refrigerant systems, controls and automated automation components, and related mechanical components and incidentals required to complete work described in this Section and make site ready for new construction.

1.2 REFERENCES

.1 CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures

1.3 DEFINITIONS

.1 Demolish: Detach items from existing construction and legally dispose or recycle items off site, unless indicated as removed and salvaged, or removed and reinstalled.

.2 Remove: Planned deconstruction and disassembly of mechanical, plumbing, heating, ventilation, air conditioning, and fire suppression systems tanking care not to damage adjacent assemblies designated to remain while maintaining the integrity and functionality of the remaining portions of systems.

.3 Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.

.4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

.5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.

.6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.4 ACTION AND INFORMATION SUBMITTALS

.1 Action Submittals: Provide the following in accordance with Section 01 33 00 - Submittal Procedures before starting work of this Section:

  .1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 03 - Waste Management.

  .2 Mechanical system pre-demolition flow rate report: Submit a report containing the fluid flow rates of the heating, ventilation and air condition system to be altered as part of the scope of work. Measure the flow rates in accordance with Section 23 05 93 Testing, Adjusting, and Balancing of Mechanical HVAC.

.2 Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

.3 Schedule of Selective Demolition Activities: Indicate detailed sequence of selective demolition and removal work, with starting and ending dates for each activity and interruption of utility services.

.4 Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finished surfaces, which might be misconstrued as damage caused by selective demolition operations.

.5 Disposal Records: If hazardous wastes are removed by the contractor, submit the following:
- .1 Hazardous Waste Transporter License.
- .2 Permit or license for hazardous waste treatment or disposal facilities.
- .3 Completed Uniform Hazardous Waste Manifest for all shipments.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

.2 Scheduling: Account for Owner's continued occupancy requirements during selective demolition with Division 00 and Division 01 and schedule staged occupancy and worksite activities.

1.6 SITE CONDITIONS

.1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition on date that tender is accepted.

.2 Owner will occupy buildings immediately adjacent to selective demolition areas. Conduct selective demolition so Owner’s operations will not be disturbed.

.3 Condition existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

.4 Hazardous Materials: Hazardous materials are present in the interior of the building to be selectively demolished.

.5 If materials suspected of containing hazardous materials are encountered that have not been indicated in the contract documents, do not disturb: immediately notify Engineer and Construction Representative.

.6 Hazardous material remediation will be completed as a portion of this contract. This work is anticipated to be sequenced with the proposed phasing of construction activities.

.7 Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

.8 Where demolition activities affect services for adjacent buildings that are outside of the demolition work, work shall be performed outside of normal operating hours of the occupants of the building.

.9 Maintain fire-protection and life safety facilities in service during selective demolition operations.

1.7 PRE-DEMOLITION MEETING

.1 Pre-demolition Conference: Conduct conference at Project site.
  .1 Inspect and discuss condition of construction to be selectively demolished.
  .2 Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  .3 Review requirements of work performed by other trades to coordinate selective demolition work.
  .4 Review areas where existing construction is to remain and requires protection.

1.8 COORDINATION

.1 It is the intent of these Specifications that all mechanical demolition work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings.

.2 Review requirements of General Demolition Contractor and work performed by other trades that rely on demolition of plumbing equipment and materials to allow for structural demolition or removal of equipment.

.3 Arrange demolition schedule so as not to interfere with Owner's on-site operations and the operations of adjacent occupied buildings.

1.9 WARRANTY

.1 Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.10 MATERIALS OWNERSHIP

.1 Except for items or materials to be reused, salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option but in compliance with ordinances and regulations related to the materials being disposed.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

.1 Plumbing Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.

.2 HVAC Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.

.3 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

2.2 DEBRIS MATERIALS

.1 Material Ownership: Demolished materials become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Owner's property.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Owner will not consider claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit.

.2 Verify that utilities have been disconnected and capped before starting demolition.

.3 Survey existing conditions and correlate with requirements indicated to determine extent of demolition required.

.4 Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged. Use photographs to document pre-existing damage.

.5 When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Construction Representative.

.6 Engage a professional engineer to survey conditions of existing structures to determine whether excavations or the removal of any element might result in structural deficiency or unplanned collapse of any portion of the existing structures during selective demolition operations.

.7 Perform surveys as the work progresses to detect hazards resulting from the execution of the work.

3.2 COORDINATION

.1 No demolition work shall be performed without prior approval of the Owner’s Representative.

.2 Demolition work shall be carried on in a manner so as not to interfere with operation of the Owner’s facilities.

.3 Any demolition work which interferes with Owner’s operations shall be scheduled with the Owner’s Representative and be subject to the Owner’s approval.

.4 Maintain existing services required to avert disruption to the Owner’s on-going operations and protect them against damage during the performance of work.

.5 Do not interrupt existing utilities serving occupied facilities except when authorized in writing by the Owner and authorities having jurisdiction.

.6 Provide temporary services during interruptions to existing utilities, as acceptable to the Owner and authorities having jurisdiction.

.7 Unless noted otherwise, provide not less than two weeks' notice to the Owner if shutdown of service is required during the execution of the work.

.8 The Contractor shall not remove any material beyond the limits indicated on the Drawings unless given permission to do so by the Owner's Representative. Any such material removed shall be replaced by the Contractor at his/her expense. If the items removed are damaged and/or cannot be satisfactorily reinstalled, new material of like construction shall be furnished and installed by the Contractor at his/her expense.

.9 All damage to buildings and utilities to remain in place shall be promptly repaired at no cost to the Owner. Repairs and restoration of accidental utility interruptions shall be made before the person responsible for the repair and restoration leaves the job site on the day of such interruption occurred.

3.3 PREPARATION

.1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:

- .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
- .2 Notify Consultant and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
- .3 Prevent debris from blocking drainage inlets.
- .4 Protect mechanical systems that must remain in operation.

.2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Owner and users is minimized and as follows:

- .1 Prevent debris from endangering the safe access to and egress from occupied buildings.
- .2 Notify Owner and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.4 SELECTIVE DEMOLITION – MECHANICAL

.1 Demolition and Removal: Coordinate requirements of this Section with information contained in Division 00 and Division 01 and as follows:

- .1 Disconnect and cap mechanical services in accordance with requirements of local Authority Having Jurisdiction.
- .2 Do not disrupt active or energized utilities without approval of the Owner.
- .3 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete.
- .4 Demolish parts of existing building to accommodate new construction and remedial work as indicated.
- .5 At end of each day's work, leave worksite in safe condition.

.6 Perform demolition work in a neat and workmanlike manner:
.1 Remove any tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
.2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.

.2 The Contractor shall use caution in the demolition of mechanical systems and shall become familiar with the conditions (fluid pressure, type, temperature) of all systems to be demolished before making any cuts or breaking any joints.

.3 All chilled water, heating water, steam, steam condensate, domestic water, waste, vent, compressed air, and fire suppression shutdowns shall be coordinated and scheduled with Owner.

.4 Prior to breaking or cutting piping or tubing within the demolished area, the Contractor shall ascertain that the system has been marked in the field or shown on the Drawings to be removed under this contract. Contact Consultant for clarification prior to demolishing or removing questionable items.

.5 Contractor shall be responsible for all isolation, draining and refilling of HVAC and plumbing piping as required by the work indicated on the drawings including planning and existing conditions research. Piping connections and local drain downs shall be coordinated for extent and timing with the Owner on an individual basis.

.6 Existing materials and equipment that remain shall be protected from damage during all disciplines of construction work. Any damage of existing materials and equipment shall be repaired or replaced to the level of existing conditions. Temporarily open pipes and equipment shall be temporarily capped and protected from construction debris and dirt.

.7 Arrange for shutoff, isolation, and lock-out of services with Owner's Representative or utility companies.

.8 When indicated on the drawings, before proceeding with selective demolition, provide temporary services/systems that bypass area of selective demolition and maintain continuity of services/systems.

.9 All remaining piping with open ends resulting from demolition work shall be promptly capped, plugged or blind flanged.

.10 Remove equipment, ductwork, and piping as indicated including hangers, rods, brackets, anchor bolts, seismic brackets and cables and other associated supports, bases, accessories and specialties.

.11 Refrigerant: Remove refrigerant from equipment to be selectively demolished. Store, transport, and dispose of hazardous liquids as per local authorities having jurisdiction.

.12 Hazardous Liquids: Remove hazardous liquids from all equipment and piping to be selectively demolished. Store, transport, and dispose of hazardous liquids as per local authorities having jurisdiction.

3.5 CLOSEOUT ACTIVITIES

.1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre).

.2 Indicate on as-built drawings: All areas where sanitary/storm piping has been cut and capped below grade for owner's record.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 The following provide insulation requirements for the following systems:
- .1 All plumbing systems.
- .2 All heating and cooling piping distribution systems.
- .3 All ventilation distribution systems.
- .4 All equipment requiring insulation.

1.2 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

.2 Thermal Insulation Association of Canada (TIAC):
- .1 TIAC Best Practices Guide 2013.

.3 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
- .1 ANSI/ASHRAE 90.1-04-SI Edition, Energy Standard for Buildings except Low-Rise Residential Buildings.

.4 ASTM International Inc.:
- .1 ASTM C177 – 13, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- .2 ASTM C 335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C 449/C 449M-07, Standard Specification for Mineral Fibre-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .4 ASTM C 533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- .5 ASTM C 547-07, Standard Specification for Mineral Fibre Pipe Insulation.
- .6 ASTM C 553-02, Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
- .7 ASTM C 612-04e1, Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
- .8 ASTM C 795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .9 ASTM C 921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.5 Canadian General Standards Board (CGSB):
- .1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.

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

.7 Underwriters Laboratories of Canada (ULC):

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

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:

.1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data will include all relevant information to confirm the specifications have been met.

.3 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 QUALITY ASSURANCE

.1 The manufacturer of the insulation will be a listed member of TRIC (Thermal Insulation Association of Canada).

.2 Performance Requirements defined: Catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.3 The contractor performing the work of this section will be a recognized installer of insulation systems and have a minimum of five (5) years' experience which can be documented and verified. The contractor will be a current and listed member of TIAC (Thermal Insulation Association of Canada).

.4 Installation will be in accordance with TIAC (Thermal Insulation Association of Canada) National Insulation Standards.

.5 Where applicable products will bear a ULC or UL label.

1.5 DEFINITIONS

.1 "Concealed": insulated piping in chase, trench, furred space, shaft, or hung ceiling. Services in tunnels are not considered concealed.

.2 "Exposed": pipe not "concealed" as defined herein.

.3 Mineral fibre: includes glass fibre, rock wool, slag wool.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

.1 All insulation systems will be ULC listed and certified.

.2 Flame spread and smoke development ratings will be in accordance with CAN/ULC S102-M88:
- .1 Maximum flame spread rating: 25.
- .2 Maximum smoke developed rating: 50.

.3 Flame proofing treatment to withstand high humidity conditions without deterioration.

.4 Materials containing asbestos are strictly prohibited.

2.2 EQUIPMENT INSULATION MATERIALS

.1 Provide adhesives, sealers, vapour coating, mastics, laggings and bedding compounds compatible with materials to which they are applied. Material not to soften, corrode or otherwise deteriorate in either wet or dry state and be of type recommended by insulation manufacturer as suitable for proposed application. Apply material within ambient temperatures recommended by manufacturer.

.2 Hot Tanks Breeching and Equipment - TIAC Code 1503-H:
- .1 Application surface temperature not to exceed 177°C (350°F).
- .2 Type: rigid mineral fibre board, without factory applied vapor retarder jacket.
- .3 Density: 68 kg/cuM (4.25 lb/cu.ft.).
- .4 R – Value 25 mm (1”) Thick Board: 0.8 K·m2/W (4.2 h·sq.ft.°F/Btu)
- .5 Conductivity: 0.032 W/sqM°C @ 24°C (0.22 Btu-in/hr.ft²°F @ 75°F).
- .6 Refer to installation instructions for material thickness required.

2.3 EQUIPMENT INSULATION FASTENINGS AND JACKETS

.1 Fastenings:
- .1 For circular tanks and vessels not exceeding 600 mm diameter utilize tie wire: 304 stainless steel, 1.5 mm (0.06”) diameter.
- .2 For circular tanks and vessels equal to or exceeding 600 mm diameter utilize bands: 304 stainless steel, 19 mm wide, 0.5 mm thick.

.2 Jackets Interior Application:
- .1 TIAC Code: CEF/2 Indoor.
- .2 Interior Jacket will be:
  - .1 Canvas: plain weave cotton fabric, 220 g/m (6.5 oz./yd.), ULC rated. Lagging adhesive: compatible with insulation. Cement: Thermal insulating and finish air drying on mineral wool.
  - .2 PVC Sheet: rigid, high gloss, white pre-formed PVC jacket, UV and bacteria resistant, flame spread 25, smoke developed 50, colour white.
  - .3 Aluminum: 0.50 mm (24 ga.) sheet, smooth finish.
  - .4 Type: 316 Stainless steel: 0.50 mm (24 ga.) sheet, smooth finish.
  - .5 Self-adhesive fabric: 11 ply fabric with zero permeability with white finish.

.3 Miscellaneous Materials:

.1 Tape: self-adhesive, aluminum, reinforced, 75 mm (3") wide minimum.

.2 Contact adhesive: quick-setting, low VOC content.

.3 Vapor retarder lap adhesive: water based, fire retardant type, compatible with insulation.

2.4 PIPE INSULATION MATERIALS

.1 Provide adhesives, sealers, vapor coating, mastics, laggings and bedding compounds compatible with materials to which they are applied. Material not to soften, corrode or otherwise deteriorate in either wet or dry state and be of type recommended by insulation manufacturer as suitable for proposed application. Apply material within ambient temperatures recommended by manufacturer.

.2 All Pipe (Hot or Cold) - TIAC Code 1501-C:

.1 Application surface temperatures not to exceed 177°C (350°F).

.2 Type: Rigid mineral fibre board, molded to fit pipe, with factory applied vapor retarder jacket.

.3 Factory Applied Facing: ASJ (All Service Jacket) vapor barrier consisting of a fiberglass yarn reinforced high density white kraft paper laminated to a thin layer of aluminum foil. The jacket will include a longitudinal, self-sealing closure lap for securing to the pipe.

.4 Density: 68 kg/cuM (4.25 lb/cu.ft.).

.5 R – Value 25 mm (1") Thick Board: 0.8 K•m2/W (4.2 h•sq.ft°F/Btu).

.6 Conductivity: 0.032 W/sqM°C @ 24°C (0.22 Btu-in/hr.ft²°F @ 75°F).

.7 Refer to installation instructions for material thickness required.

.3 Pipe Fittings:

.1 Type: rigid mineral fibre board, molded to fit fitting or valve body, with factory applied white pre-formed PVC jacket. These PVC fitting covers and jacketing, when combined, form a completely sealed system, integral to the pipe insulation system.

.2 Pre-manufactured fitting insulation assemblies will meet the performance criteria established for the Pipe insulation system.

2.5 PIPE INSULATION FASTENINGS AND JACKETS

.1 Fastenings:

.1 Stainless Steel Staples.

.2 Tie Wire: 304 stainless steel, 1.5 mm (0.06") diameter.

.3 Bands: 304 stainless steel, 19 mm wide, 0.5 mm thick.

.2 Jackets Interior Application:

.1 TIAC Code: CEF/2 Indoor.

.2 Exterior Jacket will be:

.1 Canvas: plain weave cotton fabric, 220 g/m (6.5 oz./yd.), ULC rated. Lagging adhesive: compatible with insulation. Cement: Thermal insulating and finish, air drying on mineral wool.

.2 PVC Sheet: rigid, high gloss, white pre-formed PVC jacket, UV and bacteria resistant, flame spread 25, smoke developed 50, colour white.

.3 Aluminum: 0.50 mm (24 ga.) sheet, smooth finish.

.4 Type: 316 Stainless Steel: 0.50 mm (24 ga.) sheet, smooth finish.

.5 Self-adhesive fabric: 11 ply fabric with zero permeability with white finish.

.3 Miscellaneous Materials:

.1 Tape: self-adhesive, aluminum, reinforced, 75 mm (3") wide minimum.

.2 Contact Adhesive: quick-setting, low VOC content.

.3 Vapor Retarder Lap Adhesive: water based, fire retardant type, compatible with insulation.

2.6 DUCT INSULATION MATERIALS

.1 Provide adhesives, sealers, vapor coating, mastics, laggings and bedding compounds compatible with materials to which they are applied. Material not to soften, corrode or otherwise deteriorate in either wet or dry state and be of type recommended by insulation manufacturer as suitable for proposed application. Apply material within ambient temperatures recommended by manufacturer.

.2 Concealed Square / Rectangular Duct (Hot, Cold, or Dual Temp) - TIAC Code CEF/2:

.1 Application surface temperatures not to exceed 120°C (250°F).

.2 Type: flexible mineral fibre blanket, with factory applied vapor retarder jacket.

.3 Factory Applied Facing: FSK (foil-scrim-kraft), vapour barrier consisting of aluminum foil reinforced with fibre glass yarn and laminated with fire-resistant adhesive to kraft.

.4 R – Value 38 mm (1-½") Thick Batt: 0.8 K•m2/W (4.2 h•sq.ft.°F/Btu). Installed R-value calculated with a material thickness compressed to a maximum of 25%.

.5 Conductivity: 0.042 W/sqM°C @ 24°C (0.29 Btu-in/hr.ft²°F @ 75°F).

.6 Refer to installation instructions for material thickness required.

.3 Exposed Square / Rectangular Duct (Hot, Cold, or Dual Temperature) - TIAC Code CER/2:

.1 Application surface temperatures not to exceed 177°C (350°F).

.2 Type: rigid mineral fibre board, with factory applied vapor retarder jacket.

.3 Factory Applied Facing: ASJ (all service jacket) vapor barrier consisting of a fiberglass yarn reinforced high density white kraft paper laminated to a thin layer of aluminum foil. The jacket will include a longitudinal, self-sealing closure lap for securing to the pipe.

.4 Density: 68 kg/cuM (4.25 lb/cu.ft.).

.5 R – Value 25 mm (1") Thick Board: 0.8 K•m2/W (4.2 h•sq.ft.°F/Btu).

.6 Conductivity: 0.032 W/sqM°C @ 24°C (0.22 Btu-in/hr.ft²°F @ 75°F).

.7 Refer to installation instructions for material thickness required.

.4 Exposed or Concealed Round Duct (Hot, Cold, or Dual Temp) - TIAC Code CEF/2:

.1 Application surface temperatures not to exceed 120°C (250°F).

.2 Type: flexible mineral fibre blanket, with factory applied vapor retarder jacket.

.3 Factory Applied Facing: FSK (foil-scrim-kraft), vapour barrier consisting of aluminum foil reinforced with fibre glass yarn and laminated with fire-resistant adhesive to kraft.

.4 R – Value 38 mm (1½") Thick Batt: 0.8 K•m2/W (4.2 h•sq.ft.°F/Btu). Installed R-value calculated with a material thickness compressed to a maximum of 25%.

.5 Conductivity: 0.042 W/sqM°C @ 24°C (0.29 Btu-in/hr.ft²°F @ 75°F).

.6 Refer to installation instructions for material thickness required.

2.7 DUCT INSULATION FASTENINGS AND JACKETS

.1 Fastenings:
- .1 Stainless steel staples.
- .2 Tie Wire: 304 stainless steel, 1.5 mm (0.06") diameter.
- .3 Bands: 304 stainless steel, 19 mm wide, 0.5 mm thick.

.2 Jackets Interior Application:
- .1 TIAC Code: CRF/ 1 CRD/1 Indoor.
- .2 Exterior Jacket will be:
  - .1 Canvas: plain weave cotton fabric, 220 g/m (6.5 oz/yd), ULC rated. Lagging adhesive: compatible with insulation. Cement: Thermal insulating and finish, air drying on mineral wool.
  - .2 PVC Sheet: rigid, high gloss, white pre-formed PVC jacket, UV and bacteria resistant, flame spread 25, smoke developed 50, colour white.
  - .3 Aluminum: 0.50 mm (24 ga.) sheet, smooth finish.
  - .4 Type: 316 Stainless Steel: 0.50 mm (24 ga.) sheet, smooth finish.

.3 Miscellaneous Materials:
- .1 Tape: self-adhesive, aluminum, reinforced, 75 mm (3") wide minimum.
- .2 Contact Adhesive: quick-setting, low VOC content.
- .3 Vapor Retarder Lap Adhesive: Water based, fire retardant type, compatible with insulation.

2.8 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below.

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.3 Specified Products:

.1 Equipment Insulation	John's Manville / Owens Corning
.2 Pipe Insulation	John's Manville / Owens Corning
.3 Preformed Elbows	John's Manville / Owens Corning
.4 Duct Insulation	John's Manville / Owens Corning
.5 Peel and Stick weatherproofing membrane	John's Manville / Owens Corning
.6 Jacket Canvas	Childers
.7 Jacket PVC	Childers

PART 3 - EXECUTION

3.1 GENERAL

.1 Install will be in accordance with TIAC (Thermal Insulation Association of Canada) National Standards.

.2 Prior to installation ensure that surfaces to be covered are clean and dry, insulation is clean and dry.

.3 Prior to installation ensure all pressure tests and verification of system integrity has been completed, that inspections have been performed, and that the installation of insulation systems will not hide incomplete or defective distribution systems.

.4 Cold Surfaces: Insulate all surfaces which may have a surface temperature of less than 20°C (68°F), both for energy conservation as well as to prevent ambient air meeting dew point to prevent surface condensation.

.5 Hot Surfaces: Insulate all surfaces which may have a surface temperature of greater than 62°C (145°F), both for energy conservation as well as to reduce surface temperature and prevent injury due to contact by personnel during normal duties.

.6 Maintain uninterrupted continuity and integrity of vapor retarder jacket and finishes. Ensure hangers, and supports are outside vapor retarder jacket. Provide all saddles and spacers as required.

.7 With multi-layered insulation use staggered butt joint construction. When double layering, the inner layer should not be jacketed.

.8 Identify system devices which may require periodic maintenance or inspection and provide insulating systems at such devices which permit periodic removal and replacement without damage to adjacent insulation.

.9 Locate insulation and cover seams in the least visible location. All surface finishes will be extended in such a manner as to protect all raw edges, ends and surfaces of insulation. Exposed insulation will be coated to prevent deterioration.

.10 Pressure-sensitive tape will be applied with moving pressure using a squeegee or other appropriate sealing tool.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 EQUIPMENT INSULATION APPLICATION SCHEDULE

.1 Apply thickness of insulation as listed in following table.

Equipment Insulation Application Schedule				
Equipment	Surface Temperature	Insulation Material (TIAC Code)	Insulation Thickness	Jacket (TIAC Code)
Domestic Hot Water Heat Exchangers	24°C – 82°C (75°F-180°F)	Rigid Fibre Board (1503-H)	50 mm (2”)	PVC (Green) (CEF/2)
Heating Water Heat Exchanger	61°C – 99°C (140°F-210°F)	Rigid Fibre Board (1503-H)	50 mm (2”)	Aluminum Stucco Embossed (CEF/2)
Heating Steam Heat Exchanger	38°C – 60°C (100°F-140°F)	Rigid Fibre Board (1503-H)	50 mm (2”)	Aluminum Stucco Embossed (CEF/2)
Condensate Receiver / Pumps	24°C–110°C (75°F-230°F)	Rigid Fibre Board (1503-H)	25 mm (1”)	Canvas (CEF/2)
Heating Pumps	61°C – 99°C (140°F-210°F)	Rigid Fibre Board (1503-H)	25 mm (1”)	PVC (White) (CEF/2)
Expansion Tanks	0°C – 99°C (32°F - 210°F)	Rigid Fibre Board (1501-C)	25 mm (1”)	Canvas (CEF/2)

3.4 EQUIPMENT INSULATION INSTALLATION REQUIREMENTS

.1 In addition to general installation requirements, listed above

.2 Install insulation with smooth and even surfaces, with round shapes laid to true circular and concentric shape, shaped to blend with fitting insulation and adjacent covering.

.3 Apply insulation and secure firmly with mechanical fasteners

.4 Allow for radial expansion of equipment and permit equipment to move longitudinally inside insulation and to expand and contract without opening up joints between sections.

.5 Gouge out insulation for proper fit where there is interference between weld bead and insulation.

.6 Bevel insulation away from studs and nuts to permit their removal without damage to insulation and neatly trim around extending parts of supports, sealed with insulating cement.

.7 Joints: adhere and seal laps of vapor barrier cover or vapor barrier strip of 75 mm (3") minimum width furnished with insulation, using vapor seal adhesives.

.8 Provide factory fabricated easily disassembled insulation for equipment requiring periodic maintenance of parts and sub-assemblies.

3.5 PIPE INSULATION APPLICATION SCHEDULE

.1 Apply thickness of insulation as listed in following table.

.2 The following table will encompass all piping for the systems identified as well as all in line devices and valves.

Pipe Insulation Application Schedule							
Piping Service	Pipe Surface Temperature	Insulation Material (TIAC Code)	Insulation Thickness			Jacket Exposed (TIAC Code)	Jacket Concealed (TIAC Code)
			Pipe Size ≤ NPS 2 (2"Ø)	Pipe Size NPS 2 ½ (2½"Ø) to NPS 4 (4"Ø)	Pipe Size ≥ NPS 6 (6"Ø)		
Domestic Cold Water	0°C – 24°C (32°F – 75°F)	Rigid Fibre Board (1501-C)	25 mm (1")	25 mm (1")	25 mm (1")	PVC (Green) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Domestic Hot Water	24°C – 82°C (75°F-180°F)	Rigid Fibre Board (1501-C)	25 mm (1")	25 mm (1")	38 mm (1½ ")	PVC (Green) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Domestic Hot Water Recirculation	24°C – 82°C (75°F-180°F)	Rigid Fibre Board (1501-C)	25 mm (1")	25 mm (1")		PVC (Green) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Sanitary with Condensate Drain 2.1m (7') from discharge	0°C – 24°C (32°F – 75°F)	Rigid Fibre Board (1501-C)	25 mm (1")	25 mm (1")	25 mm (1")	PVC (Green) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Sanitary Storm Drain 1.5m (5') from Roof Drain Sump	0°C – 24°C (32°F – 75°F)	Rigid Fibre Board (1501-C)	25 mm (1")	25 mm (1")	25 mm (1")	PVC (Green) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Chilled Water or Chilled Glycol Supply and Return	0°C – 24°C (32°F – 75°F)	Rigid Fibre Board (1501-C)	25 mm (1")	38 mm (1½")	38 mm (1½")	PVC (Green) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Low Temp Heating Water or Heating Glycol Supply and Return	38°C – 60°C (100°F-140°F)	Rigid Fibre Board (1501-C)	25 mm (1")	25 mm (1")	25 mm (1")	PVC (Yellow) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Steam Low Pressure Humidifier Supply	100°C (212°F)	Rigid Fibre Board (1501-C)	38 mm (1")	-	-	PVC (Yellow) (CPF/4)	
Steam Low / High Pressure Low Temp	100°C–175°C (212°F-350°F)	Rigid Fibre Board (1501-C)	38 mm (1 ½")	50 mm (2")	75 mm (3")	PVC (Yellow) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)
Steam High Temperature Super-heated	≥175°C (350°F)	Rigid Fibre Board (1501-C)	38 mm (1½ ")	65 mm (2½")	X2 Layers 50 mm (2") 100 mm (4") Total	Aluminum Stucco Embossed (CPF/3)	
Steam Condensate Pumped or Gravity	24°C–110°C (75°F-230°F)	Rigid Fibre Board (1501-C)	25 mm (1")	38 mm (1½")	38 mm (1½")	PVC (Yellow) (CPF/4)	Factory ASJ Vapor Barrier (CPF/2)

3.6 PIPE INSULATION INSTALLATION REQUIREMENTS

.1 In addition to general installation requirements, listed above.

.2 Install insulation with smooth and even surfaces, with round shapes laid to true circular and concentric shape, shaped to blend with fitting insulation and adjacent covering.

.3 Apply insulation and secure firmly with factory supplied self-sealing closure lap. Additionally utilize mechanical staples (outward facing) and self-adhesive tape where pipe size precludes use of self-sealing closure lap. Insure proper sealing of self-sealing tape with moving pressure using a squeegee or other appropriate sealing tool. Gouge out insulation for proper fit where there is interference between weld bead and insulation.

.4 Flanged Fittings: Butt insulation up to edge of flanges. Bevel insulation away from studs and nuts to permit their removal without damage to insulation. Adhere additional layer of insulation over flanged fittings overlap under laying insulation by 50 mm (2”) either side. Seal ends of additional insulation.

.5 Elbows: Utilize preformed elbows or obtain approval to utilize miter, sectional insulation for elbow insulation installation.

.6 Screwed Joints: Utilize preformed elbows or utilize excessive thickness insulation at fittings to maintain specified thickness at fittings. Gouge out insulation for proper fit at fittings. Exposed insulation will be coated to prevent deterioration.

.7 Provide factory fabricated easily disassembled insulation for equipment requiring periodic maintenance of parts and sub-assemblies.

.8 For electrically traced piping, increase insulation one size to accommodate wiring.

.9 Where pipes pass through sleeves, pack solid with mineral fibre insulation for depth of penetration. Vapor barrier jacket to be continuous. Pipe sleeves to accommodate full insulation thickness and allow pipe expansion. Provide mastic caulking.

.10 Terminate insulation at each end of unions and flanges and at other points where required, with insulation cement, CGSB 5l-GP-6M, toweled on a bevel.

3.7 DUCT INSULATION APPLICATION SCHEDULE

.1 Apply thickness of insulation as listed in following table.

.2 The following table will encompass all ducts for the system identified as well as all in line devices, dampers, etc.

Duct Insulation Application Schedule				
Service		Insulation Material (TIAC Code)	Insulation Thickness	Jacket (TIAC Code)
Supply Air Duct Cooling or Dual Temperature Service	Exposed Rectangular / Square	Rigid Fiber Board (CER/2)	25 mm (1”)	Canvas Jacket Vapor Retarder (CRF/1)
	Concealed Rectangular / Square	Flexible Batt (CEF/2)	25 mm (1”)	Factory ASJ Vapor Retarder (CRF/2)
	Exposed Round	Flexible Batt (CEF/2)	25 mm (1”)	Canvas Jacket Vapor Retarder (CRD/1)
	Concealed Round	Flexible Batt (CEF/2)	25 mm (1”)	Factory ASJ Vapor Retarder (CRD/2)
Supply Air Duct Heating Temperature Service	Exposed Rectangular / Square	Rigid Fiber Board (CER/2)	25 mm (1”)	Canvas Jacket Vapor Retarder (CRF/1)
	Concealed Rectangular / Square	Flexible Batt (CEF/2)	25 mm (1”)	Factory ASJ Vapor Retarder (CRF/2)
	Exposed Round	Flexible Batt (CEF/2)	25 mm (1”)	Canvas Jacket Vapor Retarder (CRF/1)
	Concealed Round	Flexible Batt (CEF/2)	25 mm (1”)	Factory ASJ Vapor Retarder (CRF/2)
Return Air Ducts	Exposed	None		
	Concealed	None		
Exhaust Air Ducts within 2.4 m (8’) Upstream of Exhaust Discharge or Back Draft Damper or Motorized Damper	Exposed	None	50 mm (2”)	Canvas Jacket (CRF/1)
	Concealed	None	50 mm (2”)	Factory ASJ Vapor Retarder (CRF/2)
Outside Air Ducts Up to the Air Handling Unit or Up to and Extending Downstream of the Heating Coil 1.0 m (3’) Ducts to be Considered Outside Air Downstream of any Mixing Box Section	Exposed	Rigid Fiber Board (CER/2)	x2 layers 38 mm (1½”) Offset joints Total 75 mm (3”)	Canvas Jacket (CRF/1)
	Concealed	Rigid Fiber Board (CER/2)	x2 layers 38mm (1½”) Offset joints Total 75mm (3”)	Factory ASJ Vapor Retarder (CRF/2)

3.8 DUCT INSULATION INSTALLATION REQUIREMENTS

.1 Where access doors are provided, insulation will not impede access.

.2 Provide factory fabricated easily disassembled insulation for equipment requiring periodic maintenance of parts and sub-assemblies.

.3 All longitudinal and transverse joints having a 75 mm (3”) staple flap will be secured with outward-cinching staples on approximate 150 mm (6”) centres. The seam of the joint will then be sealed with self-adhesive tape.

.4 Transverse shiplap joints not having staples flaps, or transverse butt joints will be secured with 200 mm (8”) long cross tabs running perpendicular to the joint seam on 300 mm (12”) centres. Cross tabs will be made from an approved closure tape. The seam of the joint will then be sealed with self-adhesive tape.

3.9 CLEANING

.1 During the course of, and upon completion of installation of insulation systems, remove surplus materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section will describe:
- .1 Cleaning and disinfection of potable water systems.
- .2 Cleaning and flushing requirements prior to the start-up of hydronic piping systems.
- .3 Air duct cleaning requirements prior to the start-up of ventilation systems.

1.2 COMMISSIONING

.1 Refer to Section 01 91 01 – Commissioning.

PART 2 - PRODUCTS

2.1 GENERAL

.1 In addition to those listed below, refer to the appropriate specification section for additional requirements.

2.2 POTABLE SYSTEMS

.1 Clean and Flush Medium: fresh potable water.

.2 The disinfection will be carried out by thorough flushing and then filling the system with chlorinated water at an initial concentration of 50 ppm for a contact period of 1 hour. The process has been successful if the free residual chlorine level is not less than 30 ppm at the end of this period.

.3 System will be completely flushed following disinfection.

2.3 HYDRONIC SYSTEMS

.1 All heating and cooling piping systems will be cleaned and flushed according to procedures provided by the University's approved water treatment supplier prior to operation and before being connected to the University's distribution systems.

.2 Clean and Flush Medium: fresh potable water.

.3 Water treatment chemicals to remove thread compounds, oil, grease, iron oxides.
- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

2.4 VENTILATION SYSTEM CLEANING ACCESS

.1 Equipment Access Doors and Panels: construct from same materials as equipment paneling complete with sealing gasket and positive locking device. Size access doors and panels in equipment to allow for inspection and cleaning.

.2 Ductwork Access Doors: construct access doors from same material and gauge of existing duct with gasketed seal. Ensure access door is 25 mm (1") greater in every dimension than access opening. Secure access doors with sheet metal screws on 75 mm centres minimum. Ensure [3] screws per side, top and bottom minimum.

.3 Where access doors are cut into an acoustically lined duct, utilize a water-based duct sealer for repairing cut acoustic lining.

2.5 DUCT CLEANING EQUIPMENT

.1 In duct cleaning equipment will be manual or powered equipment with the following requirements:
- .1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.
- .2 Ensure brushes are sized to fit various duct sizes in HVAC system.
- .3 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.
- .4 Replace worn and ineffective brushes when required.

.2 Vacuum Unit: includes vacuum fan, integral HEPA filter, suction hose and vacuum head, capable of maintaining HVAC System debris and particulates airborne in air stream until they reach vacuum unit and maintaining system under negative pressure.
- .1 Ensure HEPA filters are clean and maintain vacuum unit and HEPA filter to run efficiently.

PART 3 - EXECUTION

3.1 GENERAL

.1 The procedures listed below are minimum standards and do not reflect the additional requirements of any Authority having Jurisdiction that hay impose additional requirements above and beyond those listed below.

3.2 MANUFACTURER’S INSTRUCTIONS

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

3.3 POTABLE WATER CLEANING PROCEDURES

.1 After completing tests, replacement and repairs, flush domestic water systems thoroughly with potable water for 30 minutes to remove sediment.

.2 Perform disinfection as required by local authorities.

.3 Refill system immediately after flushing operation.

3.4 HYDRONIC SYSTEMS CLEANING PROCEDURES

.1 All heating and cooling piping systems will be cleaned and flushed according to procedures provided by the University's approved water treatment supplier prior to operation and before being connected to the University's distribution systems.

.2 Systems will be operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.3 Understand and inspect all piping and devices within the hydronic system. Ensure cleaning procedures and cleaning solution concentrations will do no harm to any device within the system. Replace any seals, valving, equipment damaged during the cleaning procedures.

.4 Ensure the follow prior to cleaning procedures implementation:
- .1 Strainers: clean prior to initial fill.
- .2 Control Valves: operational, fully open to ensure that terminal units can be cleaned properly.

.5 Hydronic Water Circulating System:
- .1 Thoroughly flush out each system with water.
- .2 Refill system with water chemically treated; ensure air is vented from system. Circulate for 48 to 72 hours at 80°C (180°F) temperature. Flush clean strainers. Refill immediately and add chemicals specified for system operation.
- .3 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.6 Glycol Systems:
- .1 In addition to procedures specified above perform specified procedures.
- .2 Test to prove concentration will prevent freezing to -40°C (-40°F).

3.5 HYDRONIC SYSTEMS START-UP PROCEDURES

.1 After cleaning is completed and system is filled.

.2 Establish circulation and expansion tank level, set pressure controls.

.3 Ensure air is removed.

.4 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.5 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.6 Clean out strainers repeatedly until system is clean.

.7 Commission water treatment systems as specified.

.8 Commission water/glycol fill systems as specified.

.9 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.10 Repeat with water at design temperature.

.11 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.12 Bring system up to design temperature and pressure over a 48-hour period.

.13 Perform TAB (balancing) as specified.

.14 Adjust pipe supports, hangers and springs as necessary.

.15 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.16 If expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.17 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.18 Check operation of drain valves.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This will describe the system components associated with a water sprinkler fire suppression system.

.2 This will describe the requirements for the installation of portable fire extinguishers.

1.2 RELATED REQUIREMENTS

.1 The contract documents are complementary, what is required by any one shall be as binding as if required by all. Specification sections and drawings cannot be read in isolation and it shall be the responsibility of the contractor and suppliers to ensure they have sufficient information to provide specified material and services as required by the complete contract documents.

.2 Refer to Specification Section 20 01 01 – Common Work Results Mechanical for general mechanical requirements.

.3 For equipment requiring electrical wiring connections, refer to Division 26 specification sections for applicable wiring requirements.

.4 For systems and equipment requiring painting, refer to Division 9 for painting requirements and coordinate the work with the Painting Contractor.

1.3 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 National Fire Protection Association (NFPA):
- .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
- .2 NFPA 10, Standard for Portable Fire Extinguishers.
- .3 NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- .4 NFPA 70 National Electrical Code (Fire Pump Wiring).

.3 Underwriter's Laboratories of Canada (ULC).

.4 Factory Mutual (FM).

1.4 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 -–Submittals.

.2 Product Data:
- .1 Product data shall be submitted for all PART 2 –PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor can properly layout the equipment to ensure proper access.

.4 Product data shall include all relevant information to confirm the specifications have been met.

.5 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.6 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.

.7 Product data shall include any relevant information which Division 28 requires for a properly functioning fire alarm system.

.8 Product data shall include information as specified in Section 20 01 01 -– Common Work Results Mechanical unless modified with additional information required below.

.9 Fire Pump additional information required:

.1 Fire Pump product data shall include, flow, head, NPSH, pump curves, electrical characteristics, pump controller wiring diagrams, accessories, and mounting arrangement. Certified curves shall be supplied.

.3 Shop Drawings:

.1 Drawings to provide layouts and design data for the following systems:

.1 Wet Pipe Sprinkler Systems;

.2 Submit drawings and design calculations, stamped and signed by professional engineer licensed in Province of Ontario, Canada.

.3 Drawings: Sprinkler heads and piping system layout:

.1 Prepare detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".

.2 Show data essential for proper installation of each system.

.3 Show details, plan view, elevations, and sections of systems supply and piping.

.4 Indicate grooved joint couplings and fittings on drawings.

.5 Show piping schematic of systems supply, devices, valves, pipe, and fittings.

.6 Show point to point electrical wiring diagrams.

.4 Design Data:

.1 Hydraulic calculations of sprinkler system design.

.4 Submit complete plans to Authority having Jurisdiction for review and approval before commencement of work.

.5 Commissioning Submissions:

.1 Test Reports: submit certified test reports for all fire suppression systems from an approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.6 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 00 – Closeout Procedures.

.2 Maintenance data shall include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer’s maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.
.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.
.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.5 MAINTENANCE REQUIREMENTS

.1 The Contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 The Contractor shall supply the following materials to site just prior to substantial being awarded:
.1 Provide cabinet with spare sprinklers and tools in accordance with NFPA 13.

1.6 QUALITY ASSURANCE

.1 Sprinkler system installation contractor to be a member in good standing of Canadian Automatic Sprinkler Association.

.2 Installer: company or person specializing in sprinkler system installation with 5 years documented experience and approved by manufacturer.

.3 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability. Couplings shall be UL and FM approved.

.4 Equipment and components shall bear a ULC or UL label.

.5 The Fire Pump shall be subjected to an operation test at rated speed. Performance curves are to be plotted showing the efficiency, brake-horsepower and total head developed at shut-off, at rated capacity and at 150% of rated capacity. Test each pump/driver package at factory to provide detailed performance data and to demonstrate compliance with NFPA and specification. Submit certified test curves for approval Consultant.

1.7 SPRINKLER SYSTEM DESIGN

.1 Design system in accordance with NFPA 13, using following parameters:

.2 Hazard: as indicated on drawings.

.3 Zoning: System zoning as indicated on the drawings.

.4 Water Supply: for the purposes of tendering only, the recorded water flow tests for this site were as indicated on the drawings.

.5 Water Entry: the Contractor shall arrange for, supervise and/or conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with NFPA 13.

.6 Pipe Layout: some sprinkler piping has been indicated on the design drawings, coordinate locations with other trades and existing conditions.

.7 Pipe Sizing: pipe sizes are not shown on the drawings with the exception of water entry piping. Hydraulic design all piping to NFPA 13.

.8 Sprinkler Head Layout: locate sprinkler heads as required to provide design sprinkler coverage to all spaces within the building utilizing the following:

.1 Sprinkler layout will incorporate and coordinate with the lighting and diffuser layout for the space.

.2 Sprinkler heads located in a suspended tile ceiling shall be located centre of tile or centre of half tile.

.3 Sprinkler heads shall be arranged in patterns and not randomly placed within a space.

PART 2 - PRODUCTS

2.1 GENERAL

.1 System shall be installed using industry best practices for pipe installation and run parallel to building lines. Refer to Section 20 05 05 – Installation of Pipe for piping layout and methodology.

.2 System shall be supported in accordance with NFPA 13. Refer to Section 23 05 48 – Vibration and Seismic Controls for Piping Ducts and Equipment.

2.2 WATER ENTRY

.1 Coordinate the installation of the water supply into the building with the general contractor.

.2 The water entry into the building is sized based upon expected flow to satisfy the requirements of the buildings fire suppression systems, once detailed design information is available from flow tests confirm that this pipe sizing is adequate and if advantageous to the owner, suggest revisions if required.

.3 Provide electrically supervised isolation valve at water entry.

.4 Refer to water entry detail on drawings.

.5 Slab-at-Grade Water Entry: all exterior piping shall be installed at depth to prevent freezing and conform to NFPA installation requirements. Provide seismically restrained and hydraulically braced piping for water entry into building. The sleeve or water entry pipe passing thru a foundation wall or floor will provide 100 mm (4”) clearance, 360 degrees around the pipe. The pipe penetration through the floor slab will be provided with a 2 mm (14 ga.) thick steel escutcheon plate, 50 mm (2”) greater than floor slab opening. Escutcheon plate shall not be attached to floor slab. Anchor piping at all changes of direction with concrete deadmen and clamp at building entry.

2.3 BACKFLOW PREVENTOR

.1 Preventers: to CSA-B64 Series, double check valve assembly back flow preventer. Epoxy coated cast iron construction with bronze fittings and stainless steel trim.

.2 Isolation Valves: Electrically supervised OS&Y gate valves.

.3 Size to accommodate fire suppression water flow and pressure requirements.

2.4 PIPING, FITTINGS AND VALVES

.1 Sprinkler System Pipe and Joints:
- .1 Black Steel Ferrous Pipe: to NFPA requirements and as follows:
  - .1 Up to NPS 3 (3"Ø): Schedule 40.
  - .2 NPS 4 (4"Ø) and over: Schedule 30.
- .2 Pipe Joints:
  - .1 NPS 2 (2"Ø) and under: screwed fittings with PTFE tape.
  - .2 NPS 2½ (2½"Ø) and over: welding fittings and flanges or roll grooved: [standard] [rigid] coupling to CSA B242.

.2 Fittings to NFPA Requirements:
- .1 Screwed Fittings: malleable iron, Class 150.
- .2 Welded Fittings: butt weld fittings.
- .3 Grooved Piping Fittings: grooved joints designed with two ductile iron housing segments, flush seal gasket for dry service, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact. EPDM gaskets.

.3 Pipe Hangers: ULC listed for fire protection services.

.4 Electrically Supervised Isolation Valves:
- .1 Gate Valves: UL and FM approved and labeled.
  - .1 NPS 2½ (2½"Ø) – NPS 10 (10"Ø), ductile iron bonnet, outside screw and yoke (OS&Y), bronze trim, solid taper wedge disc, with hand wheel operator. Class 125.
  - .2 Supervisory switch, electric, signals valve shut-off, two sets of single-pole, double-throw contacts with roller type switch actuator and spring loaded plunger mounted in cast aluminum housing with tamperproof cover, ULC and UL listed and labelled, FM approved.
- .2 Butterfly Valves: UL and FM approved and labeled.
  - .1 NPS 2½ (2½"Ø) – NPS 10 (10"Ø), ductile Iron body, plated ductile iron disc, EPDM seat, stainless steel shaft, with manual enclosed gear operator. Class 125.
  - .2 Integral electric supervisory switch.

.5 Swing Check Valves, Class 125:
- .1 Ductile Iron Body and Bolted Cover: with tapped and plugged opening on each side for hinge pin. Pressure rating for tight shut-off at temperatures up to maximum for seat material.

.6 Drain Valves: Ball Type, Class 125, NPS 2 (2"Ø) and under:
- .1 Body and Cap: cast high tensile bronze, screwed ends.
- .2 Ball and Seat: stainless steel solid ball and Teflon seats.
- .3 Stem Seal: TFE with external packing nut.
- .4 Operator: removable lever handle.

2.5 WET PIPE ALARM CHECK VALVES

.1 Provide wet pipe alarm check valve equipped with standard accessories, drain valves, check valves, alarm connections, pressure gauges. Valves controlling water supply and alarm shutoff to be OS&Y type with rising stem or butterfly type.

.2 Wet pipe sprinkler alarm valve shall be a straight flow design UL Listed and FM approved check type valve with grooved seat design. Alarm valve shall be listed for installation in the vertical or horizontal position. Cast or ductile iron, with bronze seat. Flanged or grooved end type, sized to suit system requirements. Alarm valve trim to be galvanized. Provide valve complete with internal components that are replaceable without removing valve from installed position.

.3 Alarm valve shall have a rated working pressure of 1250 kPa (175 PSI).

.4 Pressure type flow switch: for connection to alarm part of wet sprinkler system alarm check valve, factory adjusted to operate between 28 Pa and 56 Pa (4 and 8 PSI) on rising pressure, two sets of Form C (SPDT) contacts, instantly recycling, pneumatic retard to guard against water pressure fluctuations.

2.6 EXCESS PRESSURE PUMP

.1 Provide excess pressure pump to maintain pressure in sprinkler system piping. Pump to be capable of producing pressure boost 70 kPa (10 PSI) in excess of system pressure.

.2 Pump to be provided with necessary control valves, check valves and relief valves and to take its suction or supply side from sprinkler valve.

.3 Pump shall be 120 V / 1 phase motor and be rigidly supported.

.4 Pump to be controlled by combined manual/automatic start interconnected with high-low pressure switch installed on sprinkler valve discharge line. Pressure switch to trip on drop to pressure.

2.7 PRESSURE GAUGES

.1 Gauge shall be round, 112 mm (4”), dial type. Stainless steel bourdon tube having 0.5% accuracy.

.2 Maximum limit of not less than twice normal working pressure at point where installed.

2.8 ZONE ALARM CONTROL VALVES

.1 Zone alarm control valves shall be installed as indicated and consist of a zone isolation valve, check valve, flow switch, and inspector’s test connection with full drain capability.

.2 Isolation valve shall be butterfly type with integral electric supervisory signal wiring. Check valve to be provided to prevent system pressure fluctuation, false alarms.

.3 Flow Switch:

.1 Vane type: for wet sprinkler systems without alarm check valve, electric with pneumatic retard adjustable from 0-90 seconds, signals water pressure fluctuations to indicate leaks or flow water in excess of 38 L/m (10 USGpm), two sets of single-pole, double-throw contacts, coil spring, vane adjustment, saddle strap support unit. Assembly to be ULC and UL listed, FM approved.

.4 Test and Drain Valve:

.1 Bronze construction, brass ball, screwed connections, double outlet ball valve with one outlet with orifice equal to a single sprinkler head in the system. The second outlet would be full pipe size for drainage capacity. Fitting shall be equipped with visual site glass on the discharge side.

2.9 BUILDING FIRE DEPARTMENT PUMPER CONNECTION

.1 Unit shall be ULC listed and FM approved and bear the certification marking and location as indicated. Threads to be compatible with local fire department complete with threaded metal caps and chains.

.2 Flush Mounted Type: Double Inlet (2 x) NPS 2½ (2½"Ø) threaded swivel fire hose connections. Base with NPS 4 (4"Ø) female NPT outlet. Cast brass body with polished brass, snoots and plug caps with attaching chain. Integral double swing clappers to prevent water from exiting the second inlet when not in use. Escutcheon plate, polished brass, with lettering identifying service. Standard plate lettering either "AUTO SPKR.", "STANDPIPE" or "AUTO SPKR / STANDPIPE" to suit service.

.3 Piping from connection not to be less than NPS 4 (4"Ø). Connecting piping shall have a check valve. When installation requires that the check valve and connecting piping to fire department connection, be installed below the level of the fire department connection. The check valve will be equipped with a ball drip valve to ensure proper drainage of exterior fire department connection. Ball drip valve shall discharge to the nearest floor drain.

.4 Locate not lower the 500 mm (20"), or higher than 1000 mm (40"), from adjacent grade.

2.10 FIRE SUPPRESSION SPRINKLERS

.1 All sprinkler heads shall be standard coverage, quick response type, FM listed and ULC approved and bear the certification marking. Sprinklers shall have a rated working pressure of 1200 kPa (175 PSI).

.2 Unless indicated below all sprinklers shall be the glass bulb type, rated for 68°C (165°F) (orange or red in colour).

.1 Sprinklers in kitchen areas shall be high temperature type, 141°C (286°F) rated, (blue in colour).

.2 Sprinklers in Mechanical Rooms containing boilers or steam equipment will be sprinklers in kitchen areas shall be high temperature type, 141°C (286°F) rated, (blue in colour).

.3 Upright Sprinkler Heads (Exposed):

.1 Sprinkler frame and deflector shall be of bronze frame construction having a NPS ¾ (¾"Ø) NPT thread. Water seal assembly shall consist of an approved painted beryllium-nickel fusible solder link assembly, utilizing a strut and lever principal of operation, with Teflon-coated copper alloy cap. Bronze finish.

.2 Where upright sprinklers are installed in areas prone to access from the public (garages) or maintenance staff (Mechanical Rooms), protect sprinklers against mechanical injury by protective wire cages.

.4 Pendant Sprinkler Heads (Exposed):

.1 Sprinkler frame and deflector shall be of bronze frame construction having a NPS ¾ (¾"Ø) NPT thread. Water seal assembly shall consist of a Teflon-coated spring washer and top-loaded extruded cup with 3 mm glass bulb. Standard finish: chrome-plated. Recessed escutcheon assembly shall be a steel, two-piece escutcheon utilizing a push-on/ thread-off design with ½" adjustment. Standard finish shall be bright chrome.

.5 Sidewall Sprinkler Heads (Exposed and Semi Recessed):

.1 Sprinkler frame and deflector shall be of bronze frame construction having a NPS ¾ (¾"Ø) NPT thread. Water seal assembly shall consist of a Teflon-coated spring washer and top-loaded extruded cup with 3 mm glass bulb. Standard finish: chrome-plated. Recessed escutcheon assembly shall be a steel, two-piece escutcheon utilizing a push-on/ thread-off design with ½" adjustment. Standard finish shall be bright chrome.

.6 Refer to Part 3 for project sprinkler application.

2.11 SPRINKLER SPARE PARTS CABINET

.1 For storage of maintenance materials, spare sprinkler heads and special tools.

.2 Cabinets: 1.4 mm (18 ga.) thick steel, with baked on, red enamel corrosion resistant paint finish. Provide metal cabinet containing spare sprinklers of each type and of each melting point temperature, keys for emergency repair work and sprinkler wrench.

.3 Spare Sprinklers:

.1 System up to 300 sprinklers: 6 spare sprinklers required.

.2 System of 300 to 1000 sprinklers: 12 spare sprinklers required.

.3 System larger than 1000 sprinklers: 24 spare sprinklers required.

2.12 PORTABLE FIRE EXTINGUISHERS

.1 Multi-Purpose Dry Chemical Extinguishers: 3A 40BC rating, 2.2 kg (5 lb.) capacity, 2.4M (8') range, 13 second discharge time, stored pressure type having ammonium phosphate base with hose and shut-off nozzle labelled by Underwriters' Laboratories with wall brackets where required.

.2 Carbon Dioxide Extinguishers: 5BC rating, 2.2 kg (5 lb.) capacity, 2.4M (8') range, 9 second discharge time, insulated handle, hose and horn discharge assembly, squeeze-grip operation, fully charged, labelled by Underwriters' Laboratories with mounting brackets where required.

.3 Pressurized Water Extinguishers: 2A rating, 9 litre (2.4 gal.) capacity,12M (40') range, 40 second discharge time, stainless steel construction with hose and shut-off nozzle labelled by Underwriters' Laboratories with wall brackets where required.

.4 Multi-Purpose Wet Chemical Extinguishers: 1A / K rating, 8 litre (2.0 gal.) capacity,2.4M (8') range, 55 second discharge time, stainless steel construction with hose and shut-off nozzle labelled by Underwriters' Laboratories with wall brackets where required.

2.13 INDEPENDENT PORTABLE FIRE EXTINGUISHER CABINETS

.1 Locations as indicated on the drawings and meeting the requirements of NFPA 10.

.2 Cabinets to maintain fire resistive rating of construction in which they occur.

.3 All cabinets penetrating a fire rated wall assembly shall be double wall, insulated construction and be UL listed with a two hour vertical fire rated assembly rating: Warnock Hersey International Test Report WHI-495-1534.

.4 Tubs: 1.4 mm (18 ga.) thick steel, with baked on, white enamel corrosion resistant paint finish. Dimensions to support installed fire extinguisher.

.5 Cabinet Door: 304 Stainless Steel with satin finish. Front door will be equipped with 5 mm (1/4") thick plexi-glass full panel occupying 70% of the door area. Non-locking, flush mounted, stainless steel finger pull style latching device.

2.14 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1	Backflow Preventor	Conbraco
.2	Supervised Valves	Kitz or Nibco
.3	Excess Pressure Pump:	Armstrong, Taco, B&G, Grundfos, Goulds

.3 JLR Specified Products and bases of design:

.1	Alarm Check Valve:	Grinnel
.2	Alarm Switches	Potter
.3	Sprinklers	Grinnel
.4	Test and Drain Valve	AGF Manufacturing Ltd
.5	Portable Fire Extinguishers:	Kidd

PART 3- EXECUTION

3.1 GENERAL

.1 Do not recess, paint or conceal piping, accessories or work prior to inspection and approval by the (AHJ) Authority having Jurisdiction. Install signs required by (AHJ) Authority having Jurisdiction.

.2 Allow for expansion and contraction when installing pipe hangers.

.3 Discharge full flow drains to safe location outside building. Pipe other drains as indicated or to nearest floor drain.

.4 Assume full responsibility for protecting sprinkler heads during painting. Replace damaged and painted component.

.5 Coordinate system installation with electric lighting, mechanical ductwork and piping.

.6 Provide openings into structure necessary to install systems.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PIPE IDENTIFICATION AND PAINTING

.1 Install pipe identification in accordance with Section 20 04 01 – Mechanical Identification, supplemented as specified.

.2 Paint all standpipe piping, fittings and valves red.

.3 Paint all sprinkler piping, fittings and valves red.

3.4 SPRINKLER INSTALLATION

.1 Install and test to acceptance in accordance with NFPA 13 requirements.

.2 Install pipework in accordance with Section 20 05 05 - Installation of Pipe, supplemented as specified.

.3 Install pressure gauge at top of the highest and most remote riser.

.4 Locate components and valve operators at locations to provide clear and frequent access.

.5 Install sprinkler types as per the following table.

Location	Sprinkler Type	Sprinkler Finish
High Bay Areas **Storage Areas** **Exposed Ceiling Areas**	Upright Sprinkler Head	Bronze
Office Areas **with suspended TBar Ceilings**	Exposed Pendant Sprinkler Head	White
Office Areas **with suspended Gypsum Ceilings**	Exposed Pendant Sprinkler Head	White

3.5 TESTING

.1 General:
- .1 In accordance with NFPA requirements, supplemented as specified herein.

.2 Testing shall be witnessed by [Fire Commissioner of Canada] [Canadian Forces Fire Marshal] [authority having jurisdiction].

.3 Disposal of water used in flushing and testing to a safe location.

.4 Procedures:
- .1 Verify that system is complete prior to start-up and testing procedures.
- .2 Verify that ULC labels are visible.
- .3 Fill system with water for pressure. Record water supply pressure.
- .4 Pressure test piping system as required by authority having jurisdiction.

.5 Start-up jockey pumps.
.6 Verify flow switches are operational.
.7 Verify valves in system are visible and monitored.
.8 Flushing: fill with water, let stand at operating pressure for 1 week.
.9 Drain risers separately, then drain main.
.10 Flush buried mains and lead-in connections before making connection to indoor sprinkler system.
.11 Perform flow tests, including tests of pre-action systems, as required by:
    .1 Authority having jurisdiction.
    .2 Applicable NFPA standards such as 13, 14, 20, 1273.
    .3 Local building codes.
    .4 Record incoming pressure to building for 10 days prior to activating system.
    .5 Fill glycol legs, confirming proper operation of backflow preventers.
    .6 Adjust pressure switches.

.5 Identification: verify devices are properly labelled, identifying area served, etc.

.6 Posted Instructions: prepare schematic, mount behind glare-free glass and install where directed.

.7 Prepare valve schedule, mount behind glare-free glass and install where directed.

3.6 CERTIFICATION

.1 Perform all required acceptance tests and complete the Contractor's Material and Test Certificates as per NFPA and forward certificate to Consultant and the authority having jurisdiction.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 The section describes the pumps utilized for plumbing applications.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 NSF International / American National Standards Institute (ANSI):

.1 NSF/ANSI 61, Drinking Water System Components – Health Effects.

.3 Part 7 National Building Code.

.4 Part 7 Ontario Building Code.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:

.1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.

.4 Product data shall include all relevant information to confirm the specifications have been met.

.5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment is not supplied which is operating at their upper and lower limits for their design duty performance.

.6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.

.8 Product data shall include information as specified in Section 20 01 01 - Common Work Results for Mechanical unless modified with additional information required below.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 78 00 – Closeout Submittals.

.2 Maintenance data shall include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria edited with field observations and commissioned operational set points and adjustments.
.3 The manufacturer's maintenance and installation data.
.4 Safety informational data for maintenance staff prior to performing maintenance requirements.
.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.
.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.4 Provide copies WHMIS MSDS – Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical Equipment shall bear a CSA label or have an ESA certification.

.3 Where applicable equipment shall bear a ULC or UL label.

1.6 COMMISIONING

.1 Pumps shall be commissioned in accordance with Section 01 91 01 – Commissioning.

.2 The commissioning shall verify that the equipment is installed in accordance with the manufacturer's requirements and that the equipment has been adjusted to conform to the design performance.

1.7 TRAINING

.1 The manufacturer's representative shall be present for the training of the operational staff, on the operation and maintenance of the systems installed.

.2 The maintenance staff shall be instructed on the required maintenance schedule as well as the proper maintenance requirements and procedures for the equipment installed.

.3 The training shall inform the maintenance staff of any applicable warranties the manufacturer provides for defective material.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The products utilized shall be those accepted by the local AHJ (Authority Having Jurisdiction).

.2 The installation of the plumbing pumps shall be reviewed and installed in accordance with the local AHJ (Authority Having Jurisdiction).

2.2 DOMESTIC HOT WATER RECIRCULATION PUMP

.1 Domestic hot water booster pump shall provide circulation of domestic hot water during periods of low usage to maintain temperature of domestic hot water.

.2 Pump: Centrifugal vertical or horizontal In-Line pump style:

.1 Casing and Volute: cast (lead free) bronze or stainless steel. Standard 2 bolt flanged connections.

.2 Impeller: brass or bronze (lead free), hydraulically balanced.

.3 Shaft: stainless steel with bronze sleeve bearing, mechanical seals.

.3 Motor: TEFC type with a 1.15 service factor. CSA approved and listed, with thermal overload protection, three speed.

.4 Clock/Timer: 12 hour analog clock with am/pm indication, adjustable 24/7 timer with 15 minute intervals, manual override.

.5 860 kPa (125 PSI) maximum pressure, 107°C (225°F) maximum temperature, continuous service.

.6 Supports: provide as recommended by manufacturer.

.7 Recirculation Pump Capacity: as indicated on the drawings

2.3 ELEVATOR SUMP PUMP SUBMERSIBLE – SIMPLEX

.1 Effluent Sump Pump system shall pump sewage, not containing solids, from a sump to a gravity sewage pipe. The system shall be complete with concrete basin with cover, pump, piping, floats and controls.

.2 Pump: Centrifugal submersible pump assembly:

.1 Casing: cast iron housing, totally enclosing and sealing electrical components. Standard NPT discharge connection.

.2 Volute: cast Iron Housing. The volute shall have integrally cast legs for mounting pump on bottom of sump.

.3 Impeller: non-clogging, cast iron recessed type, machined and hydraulically balanced.

.4 Shaft: stainless steel with carbon / ceramic shaft seal.

.3 Motor: hermitically sealed within cast iron oil filled casing, CSA approved and listed, with heat sensor protection with automatic reset when motor cools to a safe operating temperature.

.4 Power Cord: power cord shall be 6M (20') in length, and sealed at the pump connection. Cords shall withstand a pull of 45 Kg (100#).

.5 Finish: exterior shall surface shall have a baked on epoxy paint finish. Pump shall have an integral stainless lifting ring mounted to the top of the pump for attachment of a lifting cable.

.6 Control and Alarm Panel: NEMA 1 enclosure, power cord, receptacle, indicator lights, audible alarm and backup power.

.7 Floats: Tilt sensitive, wide-angle, non-corrosive PVC enclosure and UL listed and CSA certified.

.8 Probes: Stainless steel.

.9 Sump high level alarm to be connected to the EMCS system.

.10 Concrete Sump: concrete, as indicated, refer to and coordinate with Division 3. Provide steel cover plate bolted and sealed to sump edge angle. Cover plate shall withstand human traffic and have rubber grommets as required sealing the installation. Refer to detail included on the drawings.

.11 Sump Pump Capacity: As indicated on drawings

2.4 CONDENSATE DRAIN PUMP

.1 Self-contained, packaged Condensate Sump Pump shall pump sewage, not containing solids, from a sump to a gravity sewage pipe or floor drain.

.2 Pump: Centrifugal Submersible Pump Assembly:

- .1 Casing: ABS plastic housing, totally enclosing electrical components. Standard barbed discharge connection.
- .2 Volute: ABS plastic.
- .3 Impeller: ABS plastic impellor, integral to pump assembly.
- .4 Shaft: stainless steel with carbon / ceramic shaft seal.
- .5 ABS plastic motor and tank cover.

.3 Motor: CSA approved and listed with thermal overload protection. Power Cord; The power cord shall be 3M (10') in length

.4 Control: integral to the pump assembly

.5 Integral check valve.

.6 Plastic ABS Sump: two litre (½ gallon) capacity.

2.5 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Domestic Hot Water Recirculation Pump: Armstrong, Taco, B&G, Grundfos, Goulds

.3 JLR Specified Products and bases of design:

.1 Submersible Sump Pump — Myers

.2 Condensate Drain Pumps — Little Giant

PART 3 - EXECUTION

3.1 GENERAL

.1 Installation of all plumbing pumps shall meet the requirements of the AHJ (Authority Having Jurisdiction).

.2 Refer to details on drawings for specific installation details.

.3 Mount domestic hot water recirculation pump as indicated, support piping either side of pump, independently from pump. Provide isolation valves either side of pump and check valve on pump discharge. Discharge piping to connect to domestic cold water supply directly upstream of domestic water heater inlet. Equip cold water inlet with isolation valve and check valve. Balance the flow rate from each domestic hot water loop.

.4 Ensure sumps are clean and water tight prior to installation of Sump Pumps. Provide non slam check valve and full flow isolation valve on discharge of sump pump, above the floor level to provide easy access. Provide chains for lifting of pumps, and secure to basin wall below access cover. Provide quick disconnecting means at pump and at main pipe connection to assist in removal of pump for servicing. Verify operation and alarm capability of sump pump controls.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PUMP START-UP PROCEDURES

.1 General:

.1 In accordance with commissioning requirements defined herein and as supplemented with the following:

.1 Procedures:

.1 Check power supply.

.2 Check starter O/L heater sizes.

.3 Start pumps, check impeller rotation.

.4 Check for safe and proper operation.

.5 Check settings, operation of operating, limit, safety controls, over-temperature, audible/visual alarms, other protective devices.

.6 Test operation of hands-on-auto switch.

.7 Test operation of alternator.

.8 Adjust leakage through water-cooled bearings.

.9 Adjust shaft stuffing boxes.

.10 Adjust leakage flow rate from pump shaft stuffing boxes to manufacturer's recommendations.

.11 Check base for free-floating, no obstructions under base.

.12 Run-in pumps for 12 continuous hours.

.13 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.14 Adjust alignment of piping and conduit to ensure full flexibility.

.15 Eliminate causes of cavitation, flashing, air entrainment.

.16 Measure pressure drop across strainer when clean and with flow rates as finally set.

.17 Replace seals if pump used to degrease system or if pump used for temporary heat.

.18 Verify lubricating oil levels.

3.4 SUMP PUMP PERFORMANCE VERIFICATION

.1 PV Procedures:

.1 Fill sump at rate slower than capacity of Pump No.1.

.2 Record levels at which Pump No.1 starts and stops. Determine flow rate by observing time taken to down water level.

.3 Fill sump at rate faster than capacity of Pump No. 1.

.4 Record levels at pump starts and stops - water level rising and falling.

.5 Check operation of alternator.

.6 Adjust level controls as necessary.

.7 Check level at which high water level alarm starts and stops. Adjust as necessary.

.2 Check removability of pumps for servicing without interfering with installation or operation of other equipment.

.3 Verify non-clog capability and maximum size of solids, using procedures recommended by manufacturer.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the materials and methods for the installation of plumbing water distribution piping within the building.

.2 This section describes the requirements for water entry piping when not attached to a fire suppression system.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME):
- .1 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
- .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .5 ANSI/SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

.3 ASTM International Inc.:
- .1 ASTM A 307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM A 536, Standard Specification for Ductile Iron Castings.
- .3 ASTM B 88M, Standard Specification for Seamless Copper Water Tube (Metric).

.4 American National Standards Institute/American Water Works Association(ANSI)/AWWA):
- .1 ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.5 American National Standards Institute/NSF International (ANSI)/NSF):
- .1 ANSI/NSF 61, Drinking Water System Components – Health Affects.

.6 Canadian Standards Association (CSA International):
- .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.

.7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):
- .1 MSS-SP-67, Butterfly Valves.
- .2 MSS-SP-70, Grey Iron Gate Valves, Flanged and Threaded Ends.
- .3 MSS-SP-71, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
- .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

.8 Part 7 National Building Code.

.9 Part 7 Ontario Building Code.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:

.1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor can properly layout the equipment to ensure proper access.

.4 Product data shall include all relevant information to confirm the specifications have been met.

.5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment is not supplied which is operating at their upper and lower limits for their design duty performance.

.6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.

.8 Product data shall include information as specified in Section 20 01 01 - Common Work Results for Mechanical unless modified with additional information required below.

.9 Additional information required;

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 78 00 – Closeout Submittals.

.2 Maintenance data shall include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer’s maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The products utilized shall be those accepted by the local AHJ (Authority Having Jurisdiction).

2.2 EXISTING DOMESTIC WATER ENTRY

.1 Install meter inside building, with ball valve on either side of meter and drain with ball valve and hose nipple for NPS 3/4 (3/4"Ø) hose on building side of valve downstream from meter. Provide locked (lock shield) valve, water meter bypass of size to comply with local water authority. If meter is not immediately available, provide companion pieces and filler pipe section. Remove filler pieces; install meter when available. Provide stanchion supports within 150 mm (6") of water meter inlet and outlet.

.2 Install pressure gauge on downstream side of meter.

.3 Provide reduced pressure principle backflow preventer downstream of meter and on building side of by-pass.

2.3 DOMESTIC WATER PIPING – BUILDING INTERIOR – COPPER

.1 Applications:
- .1 Potable Domestic Cold Water Distribution;
- .2 Potable Domestic Hot Water Distribution;
- .3 Potable Domestic Hot Water Recirculation.

.2 Piping:
- .1 Seamless copper tube, hard drawn, type L to ASTM B 88M.

.3 Fittings:
- .1 Full flow, standard radius, wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

.4 Joints:
- .1 Soldered Joints: Soldered connections utilizing lead free, 95-5 tin-antimony solder, to ASTM B 32.

2.4 DOMESTIC WATER PIPING – BUILDING INTERIOR – COPPER NPS 3 (3”Ø) AND LARGER

.1 Applications:
- .1 Potable Domestic Cold Water Distribution.
- .2 Potable Domestic Hot Water Distribution.

.2 Piping:
- .1 Seamless copper tube, hard drawn, Type L to ASTM B 88M.

.3 Fittings:
- .1 Full flow, standard radius, wrought copper and copper alloy, with roll grooves for couplings.

.4 Joints:
- .1 Ductile Iron, Grooved Couplings: designed with angle bolt pads to provide rigid joint, complete with flush seal EPDM gasket. Conforming to ANSI 61 for cold and hot potable water service (Temperature Range below freezing to 110°C (230°F).

2.5 BALL VALVES

.1 Ball Valve, Soldered End:
- .1 NPS 2 ½ (2 ½"Ø) and under, soldered.
- .2 2 piece forged brass body, full port, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat.
- .3 Extended stainless steel stem for handle operation outside insulation.
- .4 Steel lever handle, with plastic coated contact surface. Provide locking handle type for lockshield service.
- .5 Class 150 WSP, with CSA, UL and FM approval.
- .6 For services 2" and under, 600 psi WOG valves shall be used.

.2 Ball Valve, Grooved End:
- .1 NPS 3 (3"Ø) and over, grooved end.
- .2 2 piece forged brass body, full port, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat.
- .3 Extended stainless steel stem for handle operation outside insulation.
- .4 Steel lever handle, with plastic coated contact surface. Provide locking handle type for lock shield service.
- .5 Class 150 WSP, with CSA, UL and FM approval.

2.6 SWING CHECK VALVES

.1 Swing Check Valve, Soldered End:
- .1 NPS 2 ½ (2 ½"Ø) and under, soldered.
- .2 Y Pattern body, all bronze construction. Cast bronze body, screw in access cap, bronze swing disk, bronze hinge and stainless steel pin.
- .3 Class 150 WSP, conforming to MSS-SP-80.

2.7 BALANCING VALVES

.1 Pressure independent balancing device, Screwed End, Replaceable flow cartridge:
- .1 NPS ¾ (¾ "Ø) and under, screwed.
- .2 Stainless steel body, Nickel plated brass union collars, replaceable flow cartridge with stainless steel wear surfaces.
- .3 Accuracy: Flow rate +/- 5% over 95% of the control range.
- .4 NSF Certified in accordance with ANSI/NSF 61.

2.8 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Valves:	Kitz, Nibco
.2 Balancing Valves	Victaulic Series 76X

.3 JLR specified products and bases of design:

Nil

PART 3 - EXECUTION

3.1 GENERAL

.1 Support piping in accordance with the AHJ (Authority Having Jurisdiction), the Building Code, and the manufacturer's requirements.

.2 System shall be installed using industry best practices for pipe installation and run parallel to building lines. Refer to Section 20 05 05 – Installation of Pipe for piping layout and methodology.

.3 Install cold water piping below and away from hot water piping and other hot piping so as to maintain temperature of cold water as low as possible.

.4 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

.5 Install groups of pipes parallel to each other on trapeze hangers spaced to permit application of insulation, identification and service access.

.6 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.

.7 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.

.8 Ream ends of pipes and tubes before fabrication.

.9 Lay copper tubing so that it is not in contact with dissimilar metal or contact with hangers without protection.

.10 Install dielectric couplings where joining dissimilar metals.

.11 Make provision to protect water system from water hammer due to rapid operation of valves and fixtures.

.12 Make provision for thermal expansion of piping system and building structure through use of expansion joints, expansion loops and bends.

.13 Connect all fixtures and equipment supplied by Division 15 or others, unless detailed otherwise. Coordinate with architectural drawings.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 VALVE INSTALLATION

.1 Remove internal components of valve when soldering or brazing to prevent damage internal components.

.2 Install isolation valves to isolate individual equipment and fixtures with ball valves.

.3 Install isolation valves to isolate branch take offs and supplies to individual grouped washrooms with ball valves.

.4 Install valves to balance recirculation system using globe valves. Mark settings and record on as-built drawings on completion.

.5 Ensure vales are accessible for maintenance staff and are identified as to service.

.6 Provide hose bibs or sediment faucets for complete system drainage.

3.4 SYSTEM TESTING

.1 Contractor to complete installation inspection, integrity (pressure, leak) tests and support system inspection of piping system before system is insulated or enclosed. Piping not to be covered until all inspection and testing deficiencies have been corrected and successful re-testing has been completed.

.2 Test Pressure: domestic potable water system to be capable of withstanding, without leakage, water test or air test greater than one times maximum system operating pressure or 860 kPa (125 PSI) or to the authority having jurisdiction.

.3 Coordinate with authority having jurisdiction the requirement of the authority to witness tests and inspect piping system.

.4 Isolate system components not designed for test pressure during test.

3.5 FLUSHING, CLEANING AND DISINFECTION

.1 Flushing: flush entire system for 8 hours. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw a sample off longest run. Submit to testing laboratory to verify that system is clean to the potable water guidelines. Let system flush for additional 2 hours, then draw off another sample for testing.

.2 Flush out, disinfect and rinse system to the requirements of authority having jurisdiction.

3.6 PERFORMANCE VERIFICATION AND COMMISSIONING

.1 Scheduling:
- .1 Verify system performance after pressure and leakage tests and disinfection are completed.

.2 Procedures:
- .1 Verify that flow rate and pressure meet Design Criteria.
- .2 Adjust and balance flow of DHWR system.
- .3 Adjust and balance flow from fixtures to meet design specifications.
- .4 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
- .5 Verify performance of temperature controls.
- .6 Check for proper operation of water hammer arrestors. Run outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.

.3 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the domestic water piping specialities required for plumbing applications.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 In addition to those listed below, individual product specifications refer to specific references for that product.

.3 Part 7 National Building Code.

.4 Part 7 Ontario Building Code.

.5 American National Standards Institute (ANSI).

.6 American Society of Mechanical Engineers International (ASME).

.7 ASTM International Inc.

.8 American Water Works Association (AWWA).

.9 American National Standards Institute/NSF International (ANSI)/NSF):

.1 ANSI/NSF 61, Drinking Water System Components – Health Affects.

.10 Canadian Standards Association (CSA International).

.11 University of Guelph Metering Standard.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:

.1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor can properly layout the equipment to ensure proper access.

.4 Product data shall include all relevant information to confirm the specifications have been met.

.5 Product data shall provide all relevant data and operational points that verify the engineered criteria has been met and that field operational tolerances can be accommodated, i.e., equipment is not supplied, which is operating at its upper and lower limits for its design duty performance.

.6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.

.8 Product data shall include information as specified in Section 20 01 01 - Common Work Results for Mechanical unless modified with additional information required below.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 78 00 – Closeout Submittals.

.2 Maintenance data shall include but not be limited to:

.1 The manufacturer's maintenance and installation data.

.2 Safety informational data for maintenance staff prior to performing maintenance requirements.

.3 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.4 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment shall bear a CSA label or have an ESA certification.

.3 Where applicable equipment shall bear a ULC or UL label.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The products utilized shall be those accepted by the local AHJ (Authority Having Jurisdiction).

.2 Provide piping specialties as required and as specified to meet the installation requirements of the plumbing distribution systems.

2.2 WATER METERS

.1 Water meters utilized by the local utility and/or the University of Guelph, to monitor water consumption, shall be approved by the local utility and/or the University of Guelph. Coordinate the installation with the local utility and/or the University of Guelph and provide all meters required by the local utility and/or the University of Guelph.

.2 General: Water meters shall comply with ANSI / AWWA C700-09 Cold-Water Meters—Displacement Type, Bronze Main Case and NSF/ANSI 61.

.3 Domestic water meter electrode shall be constructed of stainless steel construction.

.4 Units provided with a local digital display with meters cubed (M3) and digital 4-20mA output to tie into the University of Guelph building automation system or the Schneider ION system.

.5 Provide inline electronic magnetic meter, complete with proper grounding, display and warranty.

.6 Quantify alternate flow meter to meet accuracy, specification and range of flow rate specified.

.7 Quantify accuracy specification through the range of flow rate specified for approval.

.8 To use polyurethane sensor liner.

.9 The meter body shall include grounding and empty pipe electrodes of the same material as the measuring electrodes.

.10 Meter must be H.A.R.T. compatible.

.11 The magnetic flowmeter shall be microprocessor based with integral electronics.

.12 LCD display shall enable the operator to monitor flow rate in clear text messages.

.13 The meter shall have field replaceable sensors and coils.

.14 The magnetic flowmeter shall provide an accuracy of +/- 0.5% of flow rate.

.15 It should be possible to check the functionality and verify deviation of the flow meter without needing to dismantle the device by using an external device. This Verification of transmitter electronics should be traceable to NIST or equivalent standards.

2.3 TRAP SEAL PRIMERS

.1 General: trap primers shall comply with ANSI/ASSE 1018-2001 -Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied.

.2 Standard Trap Seal Primer, Fixture Activated:

.1 Provide trap seal primers in washrooms and other areas to suit building code requirements. Primer to introduce regulated amount of water into trap or traps when the connected fixture used. Primer to be either flow activated or pressure drop activated.

.2 Construction: cast brass body, removable cap, equipped with internal vacuum breaker, non-liming internal operating piston, stainless steel spring, removable bronze seat with metering orifice, and sealed bronze cover. NPS 1/2 (1/2”Ø) solder ends, NPS ½ (1/2”Ø) drip line connection.

.3 Primer shall operate and provide trap flow at pressures below 175 kPA (25 PSI).

2.4 DIELECTRIC PIPE FITTINGS

.1 Provide dielectric fittings to isolate system components from galvanic currents. Material of dielectric fittings to suit dissimilar metals in system.

2.5 WATER HAMMER ARRESTORS

.1 General: water hammer arrestors shall comply with ASME A112.26.1M – Water Hammer Arrestors.

.2 Water hammer arrestors shall be sized for application and shall be designed to protect water lines during pressure surges following quick valve closure. This excessive pressure surge shall be absorbed by the pre-charged cushion of air permanently sealed within the water hammer arrester.

.3 Construction: lead-free copper construction, brass tailpiece and brass piston. Pre charged and sealed at the factory.

2.6 VACUUM BREAKERS

.1 General: vacuum breakers shall comply with CSA B64 SERIES-11 – Backflow Preventers and Vacuum Breakers.

.2 Vacuum breakers shall be installed in the domestic water system wherever the possibility of back siphon age and contamination of the potable water system exists.

.3 Construction: brass body, full size orifice for maximum flow, lightweight disc float with silicone seals.

2.7 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTERS

.1 General: backflow preventers shall comply with CSA B64 SERIES-11 - Backflow Preventers and Vacuum Breakers.

.2 Backflow preventers shall be selected for the appropriate application. Applications involving water supply to a system with contamination or with chemical introduced shall have a reduced pressure principle backflow preventer installed. Applications involving water supply to a system where the possible contamination is unknown, will have a reduced pressure principle backflow preventer installed.

.3 The assembly shall also include two quarter turn ball vales for isolation at the inlet and outlet, one strainer downstream of inlet ball valve, two in-line independent check valves with an intermediate relief valve, four test cocks and an air gap drain fitting.

.4 Construction:

.1 All components shall be lead free cast copper or cast bronze body construction.

.2 Silicone rubber disc material in the first and second check plus the relief valve. Replaceable polymer check seats for first and second checks. Removable stainless steel relief valve seat. Stainless steel cover bolts.

.3 Air gap drain fitting shall be cast bronze.

2.8 PRESSURE REDUCING REGULATORS

.1 General: domestic water pressure reducing regulators shall comply with CSA B356 Water Pressure Reducing Valves for Domestic Water Supply Systems.

.2 Pressure reducing valves shall be installed on potable water lines to reduce high inlet pressure to a lower outlet pressure.

.3 Capacity: maximum inlet pressure: 1034 kPa (150 PSI), outlet pressure of 172 kPa (25 PSI) to 518 kPa (75 PSI) field adjustable.

.4 Construction: lead free, cast bronze body and bell, stainless steel seat, stem, and sleeve, stainless steel strainer screen, EPDM seals. Soldered inlet and outlet connections.

.5 Pressure gauges on inlet and discharge.

.6 Soldered inlet and outlet connections.

2.9 TEMPERATURE AND PRESSURE RELIEF VALVES

.1 General: relief valves shall comply with ANSI Z21.22 / CSA 4.4-M99 Relief Valves for Hot Water Supply Systems. Valve shall be ASME rated and CSA listed.

.2 Pressure relief valves shall be selected for the appropriate application and exceed the required relief flow capacity. Pressure relief valves shall be provided as indicated and specified, and as required protecting the system from excessive pressure. Valves shall be complete with an extension thermostat for temperature monitoring and a test lever for periodic testing.

.3 Construction: main valve body to be cast brass or bronze, stainless steel internal components, silicone seals, stainless steel springs, copper encased thermostat probe.

.4 Pressure – temperature settings:

.1 Temperature relief 99°C (210°F).

.2 Pressure range 517 – 1034 kPa (75 – 150 PSI).

.3 Determine application pressure relief setting prior to installation.

2.10 MAKE-UP WATER ASSEMBLY

.1 Make up water assembly shall consist of a NPS 1 (1”Ø) main water line with isolation ball valve and NPS 1 (1”Ø) reduced pressure principle backwater valve. Downstream will be a tee connection to a NPS 1 (1”Ø) bypass around a pressure reducing valve. The bypass will be equipped with an isolation lock shield ball valve with the handle removed. The pressure reducing valve shall be NPS ½ (1/2”Ø) with isolation ball valves on the inlet and outlet. The discharge of the assembly shall be equipped with a pressure gauge and a temperature and pressure relief valve.

2.11 HOSE BIBB

.1 Hose bibb, angular, soldered end:

.1 Size as indicated, soldered.

.2 Cast brass body, PTFE packing, complete with attached tamper proof back flow preventer / vacuum breaker.

.3 Aluminum round ridged handle, with PVC coated contact surface. Zinc plated handle nut.

2.12 WALL HYDRANT

.1 Interior Wall Hydrant, Recessed / Flush Bronze Box:

.1 NPS 3/4 (3/4"Ø) wall hydrant.

.2 Chrome plated hydrant face, bronze interior parts, "anti-siphon" with integral vacuum breaker, and automatic draining wall hydrant for recessed installation. 1/2 turn ceramic disk replaceable cartridge and combination.

.3 Nickel bronze box and hinged cover with operating key lock and "WATER" stamped on cover.

2.13 NON-FREEZE WALL HYDRANT

.1 Non Freeze Exterior Wall Hydrant, Recessed / Flush Bronze Box:

.1 NPS 3/4 (3/4"Ø) frost-proof wall hydrant.

.2 Chrome plated hydrant face, bronze interior parts, "anti-siphon" with integral vacuum breaker, and automatic draining wall hydrant for recessed installation. 1/2 turn ceramic disk replaceable cartridge and combination.

.3 Nickel bronze box and hinged cover with operating key lock and "WATER" stamped on cover.

2.14 PRESSURE GAUGES

.1 Pressure Gauges: 112 mm (4-1/2 “) round dial type, stainless steel bourdon tube having 0.5% accuracy, aluminum case with glass dial cover.

.2 Scale: black embossed figures on white background indicating dual kPa and PSI pressures. Providing a 0 to 700 kPa (0 to 100 PSI) range with 50 kPa (1 PSI) increments.

.3 Provide bronze needle valve for isolation.

2.15 THERMOMETERS

.1 Thermometers: industrial type, adjustable angle, with 175 mm (7") molded polyester case and brass stem, non-mercury filled with coloured indication.

.2 Scale: black embossed figures on white background indicating dual Fahrenheit and Celsius temperatures. Providing a -1 to 115°C (30 to 240°F) range with 1°C (2°F) increments.

.3 Provide stainless bronze thermometer wells filled with heat conductive paste.

2.16 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer’s to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1	Valves	Kitz, Nibco
.2	Backflow Preventors	Zurn, Conbraco
.3	Trap Primers	Zurn, PPP, Milfab
.4	Water Hammer arrestors	Watts, Zurn
.5	Vacuum Breakers	Watts, Zurn
.6	T&P Relief Valves	Watts, Conbraco
.7	Hose Bibb	Zurn, Watts
.8	Pressure Reducing Regulators	Zurn, Watts
.9	Wall Hydrant	Zurn, Watts
.10	Non-Freeze Wall Hydrant	Zurn, Watts
.11	Thermometers and Pressure Gauges	Winters, Wika, Weiss
.12	Water Meters	Endress & Hauser, Emerson Rosemount, Spirax, Sarco

.3 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 GENERAL

.1 Installation shall be in compliance with the AHJ (Authority Having Jurisdiction).

.2 Remove internal components of valve when soldering or brazing to prevent damage internal components.

.3 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PRODUCT SPECIFIC

.1 Water Meters:

.1 Install as per utility and/or University Metering Standard and instructions and guidelines.

.2 All meter location must be accessible and located in a position that allows ease of maintenance and removal without interfering with the meter accuracy or installation practices.

.3 Meter shall be installed with proper orientation, up and down stream distances and proper grounding as per manufacturer.

.4 Provide all upstream and downstream minimum distances as specified by supplier.

.5 To make good on all surroundings after completion of installation of meter.

.6 Provide insulation by approved sub-contractor to include meter body, surrounding flanges and unions.

.7 Meters, valves, and bypasses should be supported with appropriate adjustable pipe stands. Bricks, concrete or wood blocking are not acceptable means of support.

.8 Meter installations must be checked for leakage or contaminants at completion of the installation, the proper operation of the meter should be established.

.9 For meters 2 1/2" diameter and larger provide a mechanical flange adapter on the downstream side of the meter to provide flexibility for meter and strainer case removal.

.10 All flange connections must be supplied with an asbestos-free gasket material top meet temperature and pressure for service.

.11 All documentation and related work shall be provided for the flow rate specified, commissioning, calibration, verification, performance specification and warranty related to the metering device.

.2 Trap Primers:

.1 Install trap seal primers in cold water supply and connect to trap prime connection of drain. Verify automatic water supply action.

.2 Install for floor drains and elsewhere, as indicated.

.3 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space.

.4 Install plastic tubing to floor drain. Maintain pressure in tubing during the concrete pour to prevent collapse of the tubing.

.5 Provide access door for maintenance.

.3 Water Hammer Arrestors:

.1 Install on branch supplies to fixtures or group of fixtures and as indicated.

.4 Backflow Preventers:

.1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.

.2 Provide air gap and vent elbow on backflow preventers and pipe to drain.

.5 T&P Relief Valves:

.1 Pipe discharge to drain.

.6 Strainers:

.1 Install with strainer in the down position.

.2 Install with sufficient space for strainer removal.

.7 Hose Bibb:

.1 Install hose bibbs as indicated for interior hose connections.

.2 Install at bottom of risers, at low points to drain systems, and as indicated.

.8 Wall Hydrant:

.1 Install hydrant as indicated for interior hose connections.

.2 Install 600 mm (24”) above floor height unless otherwise noted.

.3 Provide Owner with two control keys at time of building takeover

.9 Non-Freeze Wall Hydrant:

.1 Install 600 mm (24”) above finished grade unless otherwise noted.

.2 Provide Owner with two control keys at time of building takeover

.10 Pressure Gauges:

.1 Provide isolation needle valves to isolate pressure gauge for servicing.

.2 Install upstream and downstream of PRVs.

.3 Install in other locations as indicated.

.11 Thermometers:

.1 Install in wells on piping. Provide heat conductive material inside well.

.2 Install in the following location:

.1 Inlet and outlet of heat exchangers.

.2 Outlet of DHW tanks.

.3 Outlet of DHW mixing valves.

.4 In other locations as indicated.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 The section describes the materials and methods for the installation of sanitary and storm drainage piping within the building.

1.2 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

.2 ASTM International Inc.:
- .1 ASTM B 32, Standard Specification for Solder Metal.
- .2 ASTM A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
- .3 ASTM C 564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .4 ASTM A 888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- .5 ASTM C 1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- .6 ASTM D 2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- .7 ASTM D 2564, Standard Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems.

.3 Canadian Standards Association (CSA International):
- .1 CSA B67, Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
- .2 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.
- .3 CAN/CSA-B125.3, Plumbing Fittings.
- .4 CAN/CSA-B1800, Thermoplastic Non-pressure Pipe Compendium - B1800 Series.

.4 ANSI Approved / MSS Manufacturers Standardization Society:
- .1 ANSI/SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

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

.6 Part 7 National Building Code.

.7 Part 7 Ontario Building Code.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.

.4 Product data will include all relevant information to confirm the specifications have been met.

.5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment is not supplied that is operating at their upper and lower limits for their design duty performance.

.6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data will include any relevant information which Division 25 requires for a properly functioning building automation system.

.8 Product data will include information as specified in Section 20 01 01 - Common Work Results for Mechanical unless modified with additional information required below.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.

.2 Maintenance data will include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer’s maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.4 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor will verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The products utilized will be those accepted by the local (AHJ) authority having jurisdiction.

2.2 BELOW GRADE DRAINAGE PIPING – BUILDING INTERIOR – PVC

.1 All PVC piping, fitting and joining materials will conform to CAN/CSA-B1800 – Applicable Section.

.2 Buried PVC (polyvinyl chloride) drain, solvent weld bell, waste and vent pipe and fittings. Pipe will be schedule 40 solid wall pipe, intended for use in a non-pressurized piping systems where the fluid conveyed does not exceed 60°C (140°F).

.3 Fittings: PVC solvent weld bell type, same material as the piping.

.4 Joints: Solvent Weld Type: pipe joint to be an integral bell used for solvent weld. Plastic solvent cement adhesive resin will be approved by the pipe manufacturer.

2.3 ABOVE GRADE DRAINAGE PIPING – DWV COPPER

.1 Above grade DWV copper, sanitary and vent, will be Type DWV copper pipe and will conform to ASTM B 306, intended for use in a non-pressurized application.

.2 Fittings: wrought copper conforming to CAN/CSA-B125.3.

.3 Joints: soldered connections utilizing lead free, 95-5 tin-antimony solder: to ASTM B 32.

2.4 ABOVE GRADE DRAINAGE PIPING – FIRE RATED PVC

.1 This PVC piping will not be installed within a vertical service space.

.2 All PVC piping, fittings and joining materials will conform to CAN/CSA-B1800 – applicable section.

.3 Above grade PVC (polyvinyl chloride) drain, solvent weld bell, waste and vent pipe and fittings. Pipe will be schedule 40 solid wall pipe, intended for use in a non-pressurized piping systems where the fluid conveyed does not exceed 60°C (140°F). The pipe will be tested to ULC S102.2 and will have a Flame spread rated of not greater than 25 and a Smoke Development of not greater than 50.

.4 Fittings: PVC solvent weld bell type, same material as the piping.

.5 Joints: Solvent Weld Type: pipe joint to be an integral bell used for solvent weld. Plastic solvent cement adhesive resin will be approved by the pipe manufacturer.

.6 Fire Stops: fire stops will be installed when PVC piping penetrates a fire rated assembly. The fire stops will be factory produced and ULC listed for the appropriate size of hole and size of pipe. Fire stops will consist of a steel collar, attached to the structure, enclosing sufficient intumescent fire stop sealant to expand and close the pipe opening in the event of a fire. Prior to installation of the fire stop the appropriate fire stopping of the interstitial space has been completed and an appropriate escutcheon plate has been installed.

PART 3 - EXECUTION

3.1 GENERAL

.1 Support piping in accordance with the AHJ (Authority Having Jurisdiction), the Building Code, and the manufacturer's requirements.

.2 System will be installed using industry best practices for pipe installation and run parallel to building lines. Refer to Section 20 05 05 – Installation of Pipe for piping layout and methodology.

.3 All drainage piping will be sloped minimum, 1:50 (1/4" per foot), unless otherwise indicated on the drawings. Prior to installation of pipe runs, coordinate piping locations and height to determine if an interference exists with other trades.

.4 Provide all clean outs as required for drainage piping installation and in accordance with the building code.

.5 Provide all vent piping as required in accordance with the building code and proper system operation.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 BELOW GRADE PIPE INSTALLATION

.1 Provide trenching and backfilling to ensure uniform and continuous support of pipe in accordance with manufacturer's requirements. Where continuous support cannot be provided due to soil conditions provide a hanger support system from the structure above as required for an above ground installation.

.2 Maintain proper alignment and sloping during backfill and concrete pour operations.

.3 Prior to back filling, testing of the piping will be completed and inspection of the pipe by the AHJ will be completed.

.4 Excavate the trench in accordance with applicable codes and regulations, ensuring that the sides will be stable under all working conditions. The trench should be wide enough to provide adequate room for the following:

.1 Joining the pipe in the trench;

.2 Filling and compacting the side fills.

.5 The space between the pipe and trench wall must be wider than the compaction equipment used in the compaction of the backfill. Minimum width will be not less than the greater of either the pipe outside diameter plus 400 mm (16") or the pipe outside diameter times 1.25 plus 300 mm (12"). Trench width may be different if approved.

.6 Sub-soil conditions vary. The pipe backfill should be stable and provide protection for the pipe. The base of the pipe will be compacted sand. The pipe should be surrounded with Grade “A” aggregate material which is easily worked around the sides of the pipe. Backfilling should be performed in layers of 150 mm (6”) with each layer being sufficiently compacted to 85% compaction. A mechanical tamper is recommended for compacting sand and gravel backfill which contain a significant proportion of fine-grained material, such as silt and clay. If a tamper is not available, compacting should be done by hand.

.7 The trench should be completely filled. The backfill should be placed and spread in uniform layers to prevent any unfilled spaces or voids. Large rocks, stones, frozen clods, or other large debris should be removed. Heavy tampers or rolling equipment should only be used to consolidate only the final backfill.

3.4 SYSTEM VERIFICATION

.1 Cleanouts:
- .1 Ensure accessible and that access doors are correctly located.
- .2 Open, cover with linseed oil and reseal.
- .3 Verify cleanout rods can probe as far as the next cleanout, at least.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:
- .1 Verify domes are secure.
- .2 Ensure weirs are correctly sized and installed correctly.
- .3 Verify provisions for movement of roof system.

.4 Ensure fixtures are properly anchored, connected to system and effectively vented.

3.5 SYSTEM TESTING

.1 Coordinate with authority having jurisdiction the requirement of the authority to witness tests and inspect piping system. Smoke, Ball, and Pressure test systems to the requirements of the Authority having Jurisdiction.

.2 Perform a Ball Test: roll a hard dense non-floating ball (minimum 50 mm (2”) diameter down the pipe and retrieve at the end. Ball should roll freely without assistance.

.3 Leak test buried systems before backfilling. When testing, the system should be properly restrained at all bends, changes of direction, and the end of runs.

.4 Submit piping system to a hydrostatic test equivalent to 3M (10’) head. Examine each joint visually to ensure system is leakproof. Maintain original water level without replenishing for 1 hour. No water may leak from connections in system during test.

.5 Contractor to complete installation inspection, integrity (pressure leak) tests and support system inspection of piping system before system is insulated or enclosed. Piping not to be covered until all inspection and testing deficiencies have been corrected and successful re-testing has been completed.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section shall describe specialty equipment utilized for the installation of the sanitary waste system.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 In addition to those listed below, individual product specifications refer to specific references for that product.

.3 Part 7 National Building Code.

.4 Part 7 Ontario Building Code.

.5 CSA International:
- .1 CSA B79, Commercial and Residential Drains and Cleanouts.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data shall include all relevant information to confirm the specifications have been met.
- .5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment is not supplied that is operating at their upper and lower limits for their design duty performance.
- .6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
- .7 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.
- .8 Product data shall include information as specified in Section 20 01 01 – Common Work Results for Mechanical unless modified with additional information required below.

.3 Maintenance Data:
- .1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.

.2 Maintenance data shall include but not be limited to:
  .1 The manufacturer's maintenance and installation data.
  .2 Safety informational data for maintenance staff prior to performing maintenance requirements.
  .3 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.
  .4 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical Equipment shall bear a CSA label or have an ESA certification.

.3 Where applicable equipment shall bear a ULC or UL label.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The products utilized shall be those accepted by the local AHJ (Authority Having Jurisdiction).

.2 Provide drainage piping specialties as required and as specified to meet the installation requirements of the plumbing drainage systems.

.3 All drains and cleanouts shall conform to CSA B79 - Commercial and Residential Drains and Cleanouts.

2.2 FLOOR DRAINS

.1 General Duty:
  .1 Cast iron epoxy coated body, with anchor flange and NPS ½ (1/2"Ø) trap seal primer connection.
  .2 Outlet, no hub mechanical joint connection. Size as indicated, minimum NPS 3 (3"Ø) for below grade piping connections.
  .3 Cast iron epoxy coated, reversible membrane clamp with weep holes. Coordinate with Division 9 and flooring supplier to ensure suitability with flooring membrane, if required.
  .4 Adjustable head and 150 mm (6") diameter round nickel bronze strainer.

.5 Complete with the following:
.1 Sediment basket.
.2 Vandal-proof and secured grate.
.3 Recessed flooring tile flange.

.2 Combination Funnel Drain / Floor Drain:
.1 Cast iron epoxy coated body, with anchor flange and NPS ½ (1/2"Ø) trap seal primer connection.
.2 Outlet, no hub mechanical joint connection. Size as indicated, minimum NPS 3 (3"Ø) for below grade piping connections.
.3 Cast iron epoxy coated, reversible membrane clamp with weep holes.
.4 Adjustable head and 150 mm (6") diameter round nickel bronze strainer and 100 mm x 225 mm (4"x9") oval bronze funnel.

.3 Elevator Pit Drain:
.1 Cast iron epoxy coated body, with anchor flange.
.2 Side outlet, no hub mechanical joint connection. NPS 3 (3"Ø) for below grade piping connections.
.3 Cast iron epoxy coated, reversible membrane
.4 Cast iron epoxy coated, sloping grate.
.5 Complete with the following;
.1 Backwater valve, accessible for servicing thru grate.

2.3 ROOF DRAINS

.1 Roof Drain, Built Up Roofing, Full Flow:
.1 Cast iron epoxy coated body with deep sump, wide serrated flashing flange, flashing clamp and integral gravel stop. Outlet size as indicated.
.2 Provide under deck clamp, adjustable extension, and sump receiver flange for waterproofing and drain anchoring.
.3 Large Area Drain: 300 mm (12") diameter at the base, aluminum self-locking mushroom dome.
.4 Small Area Drain: 175 mm (7") diameter at the base, aluminum self-locking mushroom dome.

2.4 CLEAN OUTS

.1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

.2 Access Covers:
.1 Wall Access: face or wall type, polished nickel bronze square cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.
.2 Floor Access: round cast iron body and frame with adjustable secured nickel bronze top.

.3 Unfinished Concrete Floors: cast iron round or square, gasket, vandal-proof screws.

.4 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.

.5 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

2.5 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

- .1 Floor Drains: Watts, Zurn, Milfab, Jay Smith
- .2 Roof Drains: Watts, Zurn, Milfab, Jay Smith
- .3 Clean-outs: Watts, Zurn, Milfab, Jay Smith

.3 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 GENERAL

.1 Installation shall be in compliance with the AHJ (Authority Having Jurisdiction).

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PRODUCT SPECIFIC

.1 Floor Drains:

- .1 Provide floor drains with trap seal primers.
- .2 Coordinate installation with floor construction. Equip floor drains with seepage flange where floor is of waterproof construction.
- .3 Equip each floor drain with 0.15 mm (6 mil) polyethylene sheeting under strainer to prevent dirt from entering the system during construction. Remove polyethylene only after final cleanup.
- .4 Verify operation of trap seal primer.
- .5 Prime, using trap primer. Adjust flow rate to suit site conditions.
- .6 Cleanout baskets.

.2 Roof Drains:

- .1 Coordinate roof drain installation with Division 7 Roofing Contractor. Supply roof drains to installer for mounting in roof deck.
- .2 Make bolts for under deck clamp compatible with roof thickness.
- .3 Adjust weirs to suit actual roof slopes, meet requirements of design.
- .4 Clean out sumps.

.3 Cleanouts:

- .1 Install cleanouts at base of soil and waste stacks and rainwater leaders at locations required code, and as indicated.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Provide clean out at sanitary discharge from building.
- .4 Ensure access doors are provided and the clean outs can be properly accessed.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section includes:
  .1 Materials and installation for piping, fittings, equipment used in compressed air systems

.2 The requirements for compressed air are connection to an existing CA main which is currently not identified on the drawings, this system will be located following demolition of ceilings and designated substances. The contractor will then connect to the existing system and provide a NPS ¾ (3/4 “dia) valved quick connect connection and piping to a location near each chilled water coil within the penthouse.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
  .1 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
  .2 ASME B16.11-01, Forged Fittings, Socket-Welding and Threaded.

.2 American Society for Testing and Materials International (ASTM)
  .1 ASTM A 53/A 53M-04, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  .2 ASTM A 181/A 181M-01, Standard Specification for Carbon Steel Forgings for General Purpose Piping.

.3 Canadian Standards Association (CSA International)
  .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
  .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.

.3 Shop Drawings:
  .1 Submit shop drawings to indicate project layout including layout, dimensions and extent of piping system. Submit drawings stamped and signed by professional engineer licensed in Province of Ontario, Canada.
    .1 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

PART 2 - PRODUCTS

2.1 PIPING

.1 Piping: to ASTM A 53/A 53M, schedule 80 seamless black steel.

.2 Fittings:
.1 NPS 2” and smaller: to ASME B16.11, schedule 80 steel, screwed.

.3 Couplings: to ASME B16.11, threaded half coupling type.

.4 Unions: 1000 kPa malleable iron with brass-to-iron ground seat.

2.2 BALL VALVES

.1 To ASTM A 181/A 181M, Class 70, carbon steel body socket welded or screwed ends, stainless steel ball and associated trim suitable for compressed air application.
.2 To withstand 1034 kPa maximum pressure

.3 Owner Specified Product: Kitz or Nibco.

2.3 COUPLERS/CONNECTORS

.1 Industrial interchange series, full-bore.

.2 Maximum inlet pressure: 1700 kPa.

.3 Valve seat: moulded nylon.

.4 Body: zinc plated steel.

.5 Threads: NPT.

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 COMPRESSED AIR PIPING CONNECTIONS AND INSTALLATION

.1 Install shut-off valves at outlets, major branch lines and in locations as indicated.

.2 Install quick-coupler chucks and pressure gauges on drop pipes.

.3 Install unions to permit removal or replacement of equipment.

.4 Grade piping at 1% slope minimum.

.5 Make branch connections from top of main.

.6 Install compressed air trap at bottom of risers and at low points in mains, piped to nearest drain. Distance between drain points to be 30 m maximum.

3.3 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:
  .1 Testing: pressure test as per requirements of Section 20 01 01– Common Work Results Mechanical, for 4 hours minimum, to 1100 kPa with outlets closed. Pressure drop not to exceed 10 kPa.

.2 Manufacturer's Field Services:
  .1 Obtain reports within 3 days of review and submit immediately to Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section will describe the domestic water heaters and water heater accessories to be provided.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers:
  .1 ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings

.3 American Society of Mechanical Engineers (ASME).

.4 American National Standards Institute/NSF International (ANSI)/NSF):
  .1 ANSI/NSF 61, Drinking Water System Components – Health Affects

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 - Submittals.

.2 Product Data:
  .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
  .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
  .3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
  .4 Product data shall include all relevant information to confirm the specifications have been met.
  .5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment is not supplied which is operating at their upper and lower limits for their design duty performance.
  .6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
  .7 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.
  .8 Product data shall include information as specified in Section 20 01 01 - Common Work Results for Mechanical unless modified with additional information required below.

.3 Maintenance Data:
  .1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Close-out.
  .2 Maintenance data shall include but not be limited to:
    .1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.
    .2 The approved shop drawings with performance criteria edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer's maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.4 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: Catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment shall bear a CSA label or have an ESA certification.

.3 Fuel fired equipment shall bear a CSA label and a CGA or AGA label.

.4 Where applicable equipment shall bear a ULC or UL label.

1.6 COMMISSIONING

.1 Plumbing equipment shall be commissioned in accordance with Section 20 08 02 – Commissioning – Cleaning and Start-up of Mechanical Systems.

.2 The commissioning shall verify that the equipment is installed in accordance with the manufacturer's requirements and that the equipment has been adjusted to conform to the design performance.

.3 Manufacturer's factory trained and certified staff to start-up and commission gas fired water heaters.

1.7 TRAINING

.1 The maintenance staff shall be instructed on the required maintenance schedule as well as the proper maintenance requirements and procedures for the equipment installed.

.2 The training shall inform the maintenance staff of any applicable warranties the manufacturer provides for defective material.

1.8 WARRANTY

.1 For the Work of this Section, the 12 months contractor warranty period is extended to number of years specified for each product.

.2 The warranty shall be inclusive of the installing contractor's labour for replacement of defective products.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The products utilized shall be those accepted by the local AHJ (Authority Having Jurisdiction).

.2 Provide water heaters as required and as specified to meet the water heating requirements of the plumbing distribution systems.

.3 Water storage systems shall operate at 60°C (140°F) to prevent the growth of legionella bacteria. Mixing valves shall be provided downstream of the water storage tanks to limit the discharge temperature to 45°C (115°F).

2.2 SEMI-INSTANTANEOUS DOMESTIC HOT WATER HEATER – STEAM TO WATER SHELL AND TUBE HEAT EXCHANGER

.1 Semi-instantaneous shell and tube water heater assembly, heat exchangers shall be vertical, constructed according to ASME Boiler and Pressure Vessel Code and complying with ASHRAE 90.1

.2 Based of design and Specified Product: Digital-Flo® DFS-Semi Instantaneous Domestic Hot Water Heater DFS35DW40, 27 USGPM @ 100°F Delta T. (x2) mounted in series with bypass for a duty standby installation.

.3 The assembly shall be pre-piped steam to water semi-instantaneous shell and tube water heater assembly with performance matched components and pressure tested before delivery. The semi-instantaneous shell and tube water heater shall be of double wall construction with 5/8" 90/10 Copper/Nickel U-tubes expanded into stainless steel tube sheets with steam in the tubes and water in the shell. Heat exchanger will be fixed on one end of the shell and free floating on the opposite end designed and manufactured in accordance with ASME Code Section VIII.

.4 Temperature controller (DRV) shall be digital using integrated circuit board technology designed to deliver blended water economically at a safe, accurate temperature for sanitary use in re-circulated hot water systems. The DRV shall have a 2 line, 16 character display of delivered temperature with the option of °F or °C. Display also shows the error codes and alarm conditions. DRV shall be compliant with ASSE Standard 1017 and CSA B125, UL listed and so certified and identified. The controller shall be connected to the EMCS system and provide full functional control thru the EMCS connection.

.5 The skid shall also be equipped with additional SS thermowells for monitoring of the system by the EMCS system.

.6 The assembly shall comprise domestic side check valves, strainers, DRV, thermometers, ball valves with stainless steel ball and stem, safety shut-off valve, shell and tube exchanger insulated with 2” of Aspen Aerogel Pyrogel and aluminum jacket, all pre-piped with type L copper on a fabricated carbon steel heavy duty frame with machine grade enamel paint, Armstrong Float and Thermostatic steam trap. Shell side recirculation pump to keep the water moving in the shell and over the temperature sensing bulb. The piping and fittings in this pump line to be stainless steel.

.7 Complete assembly to be Lead Free compliant

.8 An Armstrong OB-2000 shall modulate the steam pressure on system to keep the hot water entering the DRV to be less than 250 deg. F. Designed to generate 30 GPM with a 40˚F entering cold water temperature, a 140˚F hot water outlet utilizing 10 PSIG steam.

.9 Water heater assembly shall have all of the following operational capabilities:
- .1 +/- 2˚F water temperature control from 0 to full system demand.
- .2 2˚F minimum inlet to outlet water temperature differential.
- .3 Automatic shutoff of hot water flow upon cold water inlet supply failure.
- .4 Automatic shutoff of hot water flow in the event of a power failure.
- .5 Programmable set point range of 81-158°F (27-70°C).
- .6 Programmable 1st level hi/lo temp alarm display.
- .7 Programmable error temperature error level for double safety shutdown.
- .8 LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
- .9 Isolation valves and clean in place connections to chemically clean the exchanger without disassembly of the exchanger.
  - .1 ¼" domestic side pressure relief pop-off valve with 165 psig crack pressure. Self-seating.

.10 Water heater assembly shall have the following connectivity capabilities:
- .1 SPCO relay outputs which are energized during operation.
- .2 Temperature transmitter installed on the mixed water outlet for direct connectivity to the BAS for read only monitoring of the mixed water temperature.

.11 Warranty: Pre-package skid shall have a 2 year warranty from date of installation but not longer than 27 months from date of shipment. DRV shall have a 5-year all components parts warranty.

2.3 DOMESTIC WATER EXPANSION TANKS

.1 Vertical mounted, steel pressurized diaphragm type expansion tank with polypropylene liner for containment of domestic hot water. Heavy Duty Butyl diaphragm suitable for 82°C (180°F) operation. Unit shall be built for 1035 kPa (150 PSI) working pressure. Factory pre-charged to 380 kPa (55 PSI). ASME rated.

2.4 DOMESTIC WATER TEMPERING MIXING VALVES

.1 NPS ¾ - NPS 2 (3/4"Ø – 2"Ø) Thermostatic mixing valve for tempered water system with check stops.

.2 Lead free cast bronze or brass body utilizing a paraffin-based thermostat to sense and adjust outlet temperature. Valve shall be approved to ASSE 1017 & CSA B125.3 standards:
- .1 Temperature Adjustment Range: 32 - 82°C (90 - 180°F).
- .2 Hot Water Inlet Temperature Range: 42 - 82°C (120 - 180°F).
- .3 Cold Water Inlet Temperature Range; 4 - 27°C (40 - 80°F).
- .4 Complete with fail-safe cold water bypass mode.
- .5 Outlet temperature maintained between +/- 1.2°C.

2.5 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturers to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1	Water Heater	Preston Phipps, Patterson Kelly
.2	Domestic Water Expansion Tank	Amtrol, B&G, Armstrong
.3	Domestic Water Mixing Valve	Bradley Navigator, Preston Phipps “Brain”

.3 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 GENERAL

.1 Installation shall be in compliance with the AHJ (Authority Having Jurisdiction).

.2 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.

.3 Install water heaters on a metal frame pad, height sufficient to permit condensate piping connections and maintenance. Size anchor bolts to withstand seismic zone acceleration and velocity forces.

.4 Pipe temperature and pressure relief valve discharge to funnel floor drain.

.5 Provide inlet and outlet isolation and locked bypass valve around hot water storage tanks connected in series.

3.2 MANUFACTURER’S INSTRUCTIONS

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 In addition to those listed below, individual product specifications refer to specific references for that product.

.3 Canadian Standards Association (CSA International):

.1 CAN/CSA-B45 Series - Plumbing Fixtures.

.2 CAN/CSA-B125.3 - Plumbing Fittings.

.3 CAN/CSA-B651, Accessible Design for the Built Environment.

1.2 INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.

.4 Product data shall include all relevant information to confirm the specifications have been met.

.5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment is not supplied that is operating at their upper and lower limits for their design duty performance.

.6 Product data shall identify all ancillary field installed devices and provide all information required for the co-ordination of the installation with other trades.

.7 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

.2 Maintenance data shall include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The manufacturer’s maintenance and installation data.

.3 Safety informational data for maintenance staff prior to performing maintenance requirements.

.4 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.5 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.3 QUALITY ASSURANCE

.1 Performance Requirements defined: Catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment shall bear a CSA label or have an ESA certification.

.3 Where applicable equipment shall bear a ULC or UL label.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The products utilized shall be those accepted by the local AHJ (Authority Having Jurisdiction).

.2 Fixtures, trim and accessories to be new, free from imperfections and labelled with CSA mark of approval.

.3 Plumbing fixtures of a kind, to be product of one manufacturer and white unless otherwise noted.

.4 All exposed piping shall be chrome plated and chrome plated escutcheon plates shall be provided at wall pipe penetrations.

.5 All barrier-free fixtures and trim shall comply with CSA B651 - Accessible design for the built environment.

2.2 FIXTURE MAXIMUM FLOW RATES

.1 Fixtures shall meet or be less than the code required maximum flow rates, or the flow rates identified below, whichever is less. With the exception of fixtures identified as an “ultra-low flow fixture” with a specified maximum flow.

.1	Water Closets	6.0 litre/flush (1.58 GPF)
.2	Urinals	1.9 litre/flush (0.50 GPF)
.3	Lavatory Faucet	8.35 litre/minute (2.20 GPM)
.4	Kitchen Faucet	8.35 litre/minute (2.20 GPM)
.5	Shower Heads	9.5 litre/minute (2.50 GPM)
.6	Residential Showers	7.6 litre/minute (2.50 GPM).

2.3 WATER CLOSETS

.1 General requirements for all specified Water Closets:

.1 Water closets shall comply with ASME A112.19.2 / CSA B45.1 - Ceramic Plumbing Fixtures.

.2 Water closets shall be vitreous china construction.

.3 Water closet bowls shall be elongated unless otherwise identified and complete with integral P-trap.

.4 Floor mounted water closets, top of bowl rim shall measure between 381 mm (15”) and 420 mm (16.5”).

.5 Fixtures shall operate with a minimum 175 kPa (25 PSI) water pressure. Flush valves shall operate with a minimum 310 kPa (45 PSI) water pressure.

.6 All exposed piping shall be chrome plated and chrome plated escutcheon plates shall be provided at wall pipe penetrations.

.7 All toilet seats shall be molded solid plastic and white unless otherwise identified. Toilet seats shall have stainless steel check hinges, and solid brass insert post with brass nut.

.8 Refer to drawings schedule of fixtures.

.2 Flush Assembly Options:

.1 Type 2: flush valve, polished chrome, oscillating handle manual operation, vandal proof, externally adjustable flow, diaphragm type with NPS 1 (1" diameter) water supply. Complete with screwdriver angle stop, connection and coupling for NPS 1½ (1½" diameter) top spud, wall and spud flanges with seat bumper and vacuum breaker.

.3 Toilet Seat Options:

.1 Type A: Elongated, open front, less cover.

.4 Water Closet Type WC1 – Flush Valve / Floor Mounted / Top Spud:

.1 Barrier-free design, bowl lip and seat combined height of between 410 mm (16”) and 450 mm (18”).

.2 Bowl: siphon jet flush action.

.3 Type 2 flush assembly.

.4 Type A seat.

.5 Complete with closet carrier.

2.4 LAVATORIES

.1 General requirements for all specified lavatories:

.1 Vitreous china lavatories shall comply with ASME A112.19.2 / CSA B45.1 - Ceramic Plumbing Fixtures.

.2 Porcelain enameled steel lavatories shall comply with ASME A112.19.1 / CSA B45.2 - Enameled Cast Iron and Enameled Steel Plumbing Fixtures.

.3 Stainless steel lavatories shall comply with ASME A112.19.3 / CSA B45.4 - Stainless Steel Plumbing Fixtures.

.4 All plumbing trim shall comply with ASME A112.18.1 / CSA B125.1 - Plumbing Supply Fittings.

.5 All plumbing waste fittings shall comply with ASME A112.18.2 / CSA B125.2 - Plumbing Waste Fittings.

.6 All lavatories shall be equipped with a front or back overflow.

.7 Countertop fixtures shall be complete with swivel clamps.

.8 All trim shall be lead free and comply with ANSI / NSF Standard 61.

.9 Trim with flexible tubing between fixture and isolation valves. Tubing shall be EPDM hose with external braided metal and brass connectors.

.10 Trim shall operate with a minimum 175 kPa (25 PSI) water pressure.

.11 Supplies to fixture shall be equipped with isolation valves. All exposed piping shall be chrome plated and chrome plated escutcheon plates shall be provided at wall pipe penetrations. Provide tubing to connect to fixture, EPDM hose with external braided metal and brass connectors.

.12 All lavatories shall be equipped with a NPS 1 ¼ (1 ¼" diameter) metal drain and P-Trap. P-Traps shall be equipped with unions for removal of trap. P-Traps shall be chrome plated where exposed. P-Traps shall be set back recessed style for barrier-free installations and all drainage piping shall be insulated for barrier-free installation.

.13 Refer to drawings schedule of fixtures.

.2 Trim / Drain Options:

.1 Type 1: automatic electronic control, single faucet hole. Electronic faucet suitable for barrier-free operation electrically powered. Activation of valve by electronic, sensor proximity type, activated by infra-red. Waterproof, with impact-resistant, anti-scratch coated plastic lens, sensitivity adjustable from 100 mm – 450 mm (4" – 18").

.1 Construction: polished chrome, with NPS ½ (1/2" diameter) water supply. Power: 24V operation, powered from 120V / 24V transformer sized and provided by the contractor. Wiring between transformer and valves by Division 22.

.2 Single hole.

.3 Barrier-free compliant

.4 Standard Flow Aerator: low flow orifice where required by lavatory type.

.5 Standard stainless steel drain strainer.

.3 Wall Mounted Lavatory Support System: lavatory carriers, floor mounted tubular steel construction concealed carrier to match lavatory supplied. Adjustable height, with extensions and bolt connections suitable for wall depth. Unit shall be capable of supporting 136 kg (300 lbs.). Urinal shall be mounted with lavatory lip 850 mm (34") AFF for adults and 725 mm (29") AFF for children and 800 mm (32") AAF for barrier-free applications.

.4 Lavatory Type L1:

.1 Description: countertop.

.2 Material: vitreous china.

.3 Trim: Type 1 barrier-free design.

.4 Architectural Notes: traditional STYLE, oval BOWL, white.

.5 Lavatory Type L2:

.1 Description: wall hung with integral back.

.2 Material: vitreous china.

.3 Wall mounted lavatory support system.

.4 Trim: Type 1 Barrier-free design.

.5 Architectural Notes: traditional STYLE, oval BOWL, white.

.6 Lavatory Type L3:

.1 Description: wall hung with integral back.

.2 Material: vitreous china.

.3 Wall mounted lavatory support system.

.4 Trim: Type 1 Barrier-free design.

.5 Architectural Notes: traditional STYLE, oval BOWL, white.

2.5 STAINLESS STEEL SINKS

.1 General requirements for all specified Stainless Steel Sinks unless otherwise noted:

.1 Stainless Steel Sinks shall comply with ASME A112.19.3 / CSA B45.4 - Stainless Steel Plumbing Fixtures.

.2 All plumbing trim shall comply with ASME A112.18.1 / CSA B125.1 - Plumbing Supply Fittings.

.3 All plumbing waste fittings shall comply with ASME A112.18.2 / CSA B125.2 - Plumbing Waste Fittings.

.4 Stainless Steel Sinks shall be constructed from 1 mm (20 Ga) 316 series 18-8 Stainless Steel with #5 satin finish on bowl and # 8 mirror finish on rim and counter surface. Sinks shall be self-rimming, undercoated, and countertop sinks shall be complete with swivel clamps. Each sink bowl shall be supplied with a basket strainer waste fitting with the exception of commercial dishwashing sinks which will be equipped with corner of bowl drains with standpipe overflow waste fitting. Each sink shall be factory pre drilled for trim.

.5 All trim shall be lead free and comply with ANSI / NSF Standard 61.

.6 Trim with flexible tubing between fixture and isolation valves. Tubing shall be EPDM hose with external braided metal and brass connectors.

.7 Trim shall operate with a minimum 175 kPa (25 PSI) water pressure.

.8 Supplies to fixture shall be equipped with isolation valves. All exposed piping shall be chrome plated and chrome plated escutcheon plates shall be provided at wall pipe penetrations. Provide tubing to connect to fixture, EPDM hose with external braided metal and brass connectors.

.9 All stainless sinks shall be equipped with a NPS 1½ (1½" diameter) metal drain and P-trap (single P-trap for double sinks). P-traps shall be equipped with unions for removal of trap. P-traps shall be chrome plated where exposed. P-traps shall be set back recessed style for barrier-free installations and all drainage piping shall be insulated for barrier-free installation.

.10 Where required provide tee fitting for dishwasher pumped drain connection.

.11 Refer to drawings schedule of fixtures.

.2 Trim / Drain Options:

.1 Type 1: manual pivot action single lever handle control, single hole sink:

.1 Metal construction, polished chrome finish, ceramic / stainless steel cartridge style mixing assembly.

.2 Sink hole on sink.

.3 Barrier-free compliant.

.4 225 mm (9") long, 180° swivel spout.

.5 Standard Flow Aerator: low flow orifice where required by sink type.

.2 Type 4: bar sink style. Manual pivot action single lever handle control, single hole sink:

.1 Metal construction, polished chrome finish, ceramic / stainless steel cartridge style mixing assembly.

.2 Sink hole on sink.

.3 Barrier-free compliant.

.4 225 mm (9") high, gooseneck spout.

.5 Standard Flow Aerator: low flow orifice where required by sink type.

.3 SS Sink Type SS1- Kitchen Single Compartment Sink:

.1 Description: single compartment countertop with ledge back.

.2 Compartment Size: 330 mm wide x 228 mm bowl, 150 mm deep (13"x11"x6").

.3 Trim: Type 4.

.4 SS Sink Type SS1- Kitchen Double Compartment Sink:

.1 Description: double compartment countertop with ledge back.

.2 Compartment Size: both 380 mm wide x 410 mm bowl, 200 mm deep (15”x16”x8”).

.3 Trim: Type 1.

2.6 SERVICE SINKS

.1 Mop Sink – MS1 – Floor Mounted:

.1 Basin: floor mounted base, molded stone, 610 mm x 610 mm x 254 mm (24" x 24" x l0") deep.

.2 Supply: 200 mm (8") combination type, chrome plated, with vacuum breaker, indexed cross handles, heavy cast brass spout with NPS 3/4 (3/4" diameter) hose thread and pail hook, aerator, adjustable brace to wall, integral stop valves.

.3 Strainer: cast brass, chrome plated, coupling with two (2) neoprene gaskets, combination stainless steel dome strainer and lint basket, NPS 3 (3" diameter) outlet.

.4 Wall Guard: 304 Stainless Steel sheet metal, #5 satin finish, to extend 1800 mm (6’) vertically above and to sides and 600 mm (24”) horizontally from edge of mop sink and be glued and screwed to adjacent wall.

.5 Wall mounted eyewash above mop sink.

.6 Accessories: provide stainless steel mop hanger with 3 holders with rubber tool grips.

.2 Service Sink:

.1 One piece molded fibre glass / resin reinforced design, single compartment laundry sink, bowl dimension 560 mm x 560 mm (22" x 22") exterior, 340 mm (13½") deep. Unit with back ledge and legs for floor mounting.

.2 Supply Fitting: cast brass deck type, 150 mm (6") swing spout, aerator, lever handles, set screw flanges.

.3 Stainless steel strainer, with rubber stopper. Cast brass NPS 1 ½ (1 ½” diameter) P-trap with cleanout.

2.7 DRINKING FOUNTAINS AND REFRIGERATED WATER COOLERS

.1 General requirements for all specified Drinking Fountains / Water Coolers unless otherwise noted:

.1 Stainless Steel Drinking Fountains shall comply with ASME A112.19.3 / CSA B45.4 - Stainless Steel Plumbing Fixtures.

.2 All Refrigerated Drinking Fountains shall comply with ANSI / ARI Standard 1010.

.3 All components shall be lead free and comply with ANSI / NSF Standard 61.

.4 Fixtures shall operate with a minimum 175 kPa (25 PSI) water pressure.

.5 Supplies to fixture shall be equipped with isolation valves.

.6 All Drinking Fountains shall be equipped with a NPS 1¼ (1¼” diameter) metal drain and P-Trap (single P-Trap for each fountain).

.2 Refrigerated Water Cooler: Stainless Steel, Wall Mounted, Barrier-Free with Bottle Filler:

.1 1.27 mm (18 Ga) 304 stainless steel with satin finish.

.2 Single bowl, mounted proud from wall and at height to meet barrier-free application.

.3 Water shall be filtered and provide lead, chlorine, particulate, taste and odor reduction. Filters shall be capable of a minimum total flow of 5675 litre (1500 Gal).

.4 Bubbler Head: polished chrome-plated forged brass, integral basin shank, and anti-squirt vandal-resistant bubbler head.

.5 Pushbutton Valve: lead-free forged brass; push activated, stream regulator and self-closing mechanism. Adjustable flow rate. Polished chrome-plated pushbutton requiring less than 2.3 kg (5 lbs) to activate.

.6 Infrared sensor activation bottle filler, with automatic 20-second water flow shut-off. Quick fill rate of 5.6 L/m (1.5 Gpm).

.7 Waste Strainer: polished chrome-plated brass vandal-resistant combination waste strainer and tailpiece assembly.

.8 Packaged hermetic R410 unit with pre-cooler, insulated double wall chiller, storage tank, air-cooled condenser, thermostatically controlled. Counter flow cooling evaporator/chiller, large capacity dryer-strainer and fan-cooled condenser, controlled by calibrated capillary tube.

.9 Back Panel: satin finish stainless steel back panel with louvered opening as required for compressor and evaporator operation.

.10 Electrical 115/1/60, 5.0 FLA, 370 W.

.11 Warranty: five (5) years on sealed refrigeration system, two years on all other components.

.12 Provide factory manufactured floor-mounted carrier systems for all wall-mounted drinking fountains.

2.8 TRANSFORMERS

.1 Control Transformers shall be 120V - 24V, 60 Hertz transformers, installed to meet the power requirements of the connected devices with an additional 25% spare capacity.

.2 Transformers shall be ULC listed and CSA certified.

.3 Standard design shall be single phase, all welded core construction made with high quality, high permeability silicon steel laminations. Coils shall be accurately wound with high quality magnetic wire with insulation film. All units from 50VA to 5kVA are encapsulated with electrical grade silica sand and resin compounds. Transformers shall be complete with heavy duty NEMA 3 Conduit knockouts on sides and rear of enclosure. Front accessible wiring compartment with high and low voltage copper lead wires or tabs. Ample space for transformer connection for primary and secondary terminations.

.4 Insulation: up to 1 kVA; Class B, 80°C temperature rise. 1.5 to 5 kVA; Class F, 115°C temperature rise.

.5 Mounting: designed for vertical or horizontal mounting.

2.9 JLR SPECIFIED PRODUCTS

.1 Refer to Section 20 02 15 - JLR Mechanical Manufacturer's Quality Assurance List for listing of alternate manufacturer's to those listed below.

.1	Water Closets, Basis of Design	American Standard
.2	Urinals, Basis of Design	American Standard
.3	Lavatories, Basis of Design	American Standard

.4	Stainless Steel Sinks, Basis of Design	Kindred
.5	Service Sinks, Basis of Design	Fiat
.6	Drinking Fountains, Basis of Design	Haws

PART 3 - EXECUTION

3.1 GENERAL

.1 Installation shall be in compliance with the AHJ (Authority Having Jurisdiction).

.2 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.

.3 Provide supports, required to set fixtures level and square. Mount fixtures so that 90 kg (200#) weight will not loosen or distort mounting. Fasten fixtures on walls or partitions with 12 mm (½") carriage bolts passing through wall to 3 mm (1/8") steel plates (recessed where required) on other side of wall.

.4 Protect units with water-resistant temporary covering. Do not allow temporary use of plumbing fixtures.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 FIXTURE ADJUSTMENT

.1 Conform to required water conservation requirements.

.2 Adjustments:

- .1 Adjust water flow rate to design flow rates.
- .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
- .3 Adjust flush valves to suit actual site conditions.
- .4 Adjust urinal flush timing mechanisms.
- .5 Set controls of automatic flush valves for WCs and urinals to prevent unnecessary flush cycles.

.3 Checks:

- .1 Water closets, urinals: flushing action.
- .2 Aerators: operation, cleanliness.
- .3 Vacuum breakers, backflow preventers: operation under all conditions.
- .4 Thermostatic controls: Verify temperature settings, operation of control, limit and safety controls.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section will describe the requirements for testing, adjusting, and balancing of mechanical systems.

.2 TAB is used throughout this section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.3 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.

.4 TAB will be performed on all of the following systems:

- .1 Plumbing (domestic hot water distribution).
- .2 Heating Piping Systems.
- .3 Heating Equipment.
- .4 Cooling Piping Systems.
- .5 Cooling Equipment.
- .6 Ventilating and all Air Distribution Systems: Supply, Return, Exhaust, and Outside Air Ventilation Systems.
- .7 Ventilation Equipment.
- .8 Special Exhaust Systems and Equipment.

1.2 PURPOSE OF TAB

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

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

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.3 QUALITY ASSURANCE

.1 Carry out balancing in accordance with ANSI/ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building, Heating, Ventilation, Air Conditioning, and Refrigeration Systems.

.2 The contractor performing the work of this section will be a recognized and independent balancing contractor and have a minimum of five (5) years' experience that can be documented and verified.

.3 The TAB contractor will be recognized and registered with one or more of the following organizations:

- .1 AABC - Associated Air Balance Council.
- .2 NEBB - National Environmental Balancing Bureau.
- .3 TABB - Testing Adjusting and Balancing Bureau.
- .4 NBC - National Balancing Council.

.4 TAB: will be performed in accordance with the requirements of the standard under which the TAB firm's qualifications were approved.

.5 Identify the balancing sub consultant and submit the names of company to the Consultant within 30 days of award of contract. Provide documentation confirming qualifications and successful experience.

.6 The preceding requirements for regulatory qualifications will only be suspended for the following considerations:

.1 It can be shown that there are no balancing companies meeting these requirements within a 150 km (95 mi) distance as measured from the balancing companies address to the construction site via google maps.

.2 If the contractor can provide a letter from the qualified companies within the allotted distance, indicating they are unable or otherwise occupied and cannot perform the work.

.7 Should the regulatory requirement be suspended, the preferred qualifications of the TAB contractor will be, in order of preference:

.1 An independent balancing contractor, with the minimum five (5) years' experience.

.2 A member of the sheet metal contractor's staff who is familiar with balancing methods and equipment.

.8 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.9 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist for calibration of TAB instruments. Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

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

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

.12 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 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

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

.3 National Balancing Council, (NBC) Certified Air Balancing Specifications and Certified Hydronic Balancing Specifications.

.4 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

.5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems – Testing, Adjusting and Balancing.

1.5 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Following the naming of the TAB firm, within 30 days of award of contract. The TAB firm will submit the proposed report documentation standard forms for review and approval to the Consultant.

.3 General Reporting Requirements:

- .1 Review specifications and drawings, make site visits, prepare reports and ensure all systems operate to specified requirements.
- .2 Conduct minimum of two (2) site visits during course of construction and make recommendations to ensure proper provisions are made for testing and balancing. Ensure that modifications are implemented prior to executing work.
- .3 Undertake start-ups balancing after start-up/operation reports are completed. Submit start-up balancing reports for equipment and system performance, including actions required to conform to contract documents.
- .4 Undertake preliminary balancing after preliminary verification of controls is completed. Submit preliminary balancing reports for systems and controls, including actions required to conform to contract documents.
- .5 Undertake final balancing after final verification of controls is completed. Submit final balancing report for systems and controls, including actions required to conform to contract documents. Identify and schedule seasonal balancing work required.
- .6 Carry out seasonal balancing and provide system performance report.

.4 Initial Review Report:

- .1 Initial review report, identifying locations where additional balancing devices will be advantageous to the performance of the TAB work.

.5 Preliminary Balancing Report:

- .1 The preliminary balancing report will be provided should rough balancing indicate a problem with equipment and/or site conditions that indicate that the final balancing will be unable to achieve the performance requirements.

.6 All TAB Reports will be submitted in both Metric and Imperial Units.

.7 Final TAB Ventilation System Balancing report to include:

- .1 TAB Ventilation report will include schematic representation of all diffusers within a system, referenced to the individual diffuser / air moving equipment air flow reports.
- .2 Equipment: Fans / Air Handling Equipment report to include:
  - .1 Manufacturers' Data: manufacturer and model.
  - .2 Size, arrangement discharge and class.
  - .3 Coil types, row and fin quantity.
  - .4 Filters: quantity, type.
  - .5 Design Data:
    - .1 Airflow.
    - .2 Static pressure (suction, discharge, total).
    - .3 Fan RPM.
    - .4 Motor size, RPM, voltage, phase and FLA.

.6 Measured Data:
  .1 Airflow.
  .2 Static pressure.
  .3 Fan RPM.
  .4 Pulley sizes.
  .5 Belt size and quantity and condition.
  .6 Motor size, RPM.
  .7 Motor manufacturer and type.
  .8 Motor operating amps, voltage, phase.
.7 Static pressure reading between all components of Air Handling Units:
  .1 Upstream and downstream of coils and heat exchangers.
  .2 Upstream and downstream of filters.
  .3 Upstream and downstream of dampers and air mixing devices.
.8 Filters: condition at the time of balancing.
.9 Positions of dampers at the time of balancing.
.10 Recorded duct air flows for return and outside air quantities at mixing boxes.
.11 Verify and report on performance minimum and maximum volume conditions under variable volume control and at minimum and maximum outside air condition under economizer control.
.12 Minimum air flow damper setting and air flows.
.13 Inlet and outlet temperatures for air handling units, including return and outside air temperatures.
.14 Inlet and outlet temperatures across coils and heat exchangers.

.3 Duct Air Quantities: Mains, Branches, Fresh Air and Exhaust Identification:
  .1 Duct sizes.
  .2 Number of pressure readings.
  .3 Sum of velocity measurements.
  .4 Average velocity.
  .5 Duct recorded air flow.
  .6 Duct design air flow.

.4 Air Inlets and Outlets: Supply, Return or Exhaust Outlet:
  .1 Identification (location and number designation).
  .2 Design and measured velocities.
  .3 Design and measured air flows.
  .4 Deflector vane or diffusion cone settings.

.5 Terminal Units:
  .1 Identification.
  .2 Design and measured airflow.
  .3 Design and measured static pressure.
  .4 Minimum and maximum recorded airflow and static pressure.
  .5 Position of controlling devices and applied set points to achieve minimum and maximum settings.

.8 Final TAB Hydronic System Balancing Report to include:

.1 Hydronic System report will include schematic representation of all devices within a system, referenced to the individual coils / equipment fluid flow reports.

.2 Equipment: Pump Report to include:

.1 Manufacturer Data: manufacturer and model.

.2 Size, arrangement inlet and discharge pipe sizes.

.3 Maximum pump impellor size and machine impellor size supplied with pump.

.4 Design Data:

.1 Pump Flow.

.2 Pump Head.

.3 Pump RPM.

.4 Motor Size, RPM, Voltage, Phase, and FLA.

.5 Measured Data:

.1 Pump Flow.

.2 Pump Head.

.3 Pump RPM.

.4 Motor Size, RPM.

.5 Motor Manufacturer and Type.

.6 Motor Operating Amps, Voltage, Phase.

.6 Suction and discharge pressures of pump assembly including isolation valves, check valves, suction diffusers, triple duty valves, and strainers.

.7 Suction and discharge pressure of strainers at inlet of pump.

.3 Equipment: Heat Exchanger:

.1 Manufacturer Data: manufacturer and model.

.2 Report to include Design Data, Manufacturer Design Data, and Measured Data for the following:

.1 Fluid Flow.

.2 Inlet and Outlet Fluid Pressure.

.3 Pressure Drop across Equipment.

.4 Entering and Leaving Fluid Temperatures.

.3 Equipment Electrical Data both design and measured, including amp reading on all phases.

.4 Steam Heat Exchangers to include steam inlet pressure.

.4 Forced Air Coils:

.1 Coil Type, Rows and Fins.

.2 Fluid Flow.

.3 Fluid Pressure Drop across Coil.

.4 Entering and Leaving Fluid Temperatures.

.5 Coil Airflow.

.6 Entering and Leaving Air Temperatures (dry bulb and wet bulb).

.7 Coil Control Valve Type (2 Way, 3 Way).

.8 Balancing Circuit Setter Position Setting.

.9 Bypass Balance Set Point.

.5 Convectors and Radiators:

.1 Fluid Flow.

.2 Balancing Circuit Setter Position Setting.

.9 Domestic Water Recirculation Distribution Balancing Report to include (for all balancing valves):

.1 Fluid Flow.

.2 Balancing Circuit Setter Position Setting.

1.6 DOCUMENT REQUIREMENTS

.1 The contractor will provide the TAB firm a full copy of the contract drawings and specifications, including all addenda and change orders.

.2 Contractor to provide TAB firm with 1 set of shop drawings for all equipment supplied.

.3 The TAB firm will submit the proposed report documentation standard forms for review and approval to the Consultant and the commissioning agent.

1.7 COMMISSIONING

.1 Refer to Section 01 91 01 - Commissioning.

1.8 COORDINATION

.1 Coordinate the efforts and requirements of TAB with the commissioning agent. Be aware of the commissioning schedule and participate in the commissioning process.

.2 TAB will be performed in conjunction with the Division 25 activities. Provide all required control set point for inclusion in the controlled programing.

.3 During the course of completion of TAB work, identify and include in reports construction variances such as:

.1 Piping or conduit penetrating ducts.

.2 Open holes in ductwork.

.3 Collapsed ductwork.

.4 Leaks in hydronic systems.

.5 Inaccessible valves and dampers.

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

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

1.9 MEASUREMENT TOLERANCES

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

.2 Do TAB to following tolerances of design values:

.1 Ventilation Systems: plus 5%, minus 5%.

.2 Hydronic systems: plus or minus 10%.

.3 Supply and Exhaust systems: plus 5%, minus 5%.

1.10 VERIFICATION

.1 Reported results subject to verification by the commissioning agent and/or Consultant.

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

.3 The Consultant will identify the number and location of measurements to be verified. They or their agents will be present and witness the verification of results.

.4 Costs incurred due to the failure and of the verification of results and subsequent re balancing of systems will not be reimbursed.

.5 Failure to verify the reported results will NOT be included as part of the required number of verifications to be performed.

PART 2 – PRODUCTS

2.1 GENERAL

.1 The TAB firm / Contractor will use the recognized industry standard for measuring equipment available.

.2 The equipment utilized will provide measured reading meeting the required accuracy.

.3 The utilization of outdated or non-calibrated equipment for the performance of TAB will result in the recommencement and rejection of all reports and measurements made. The contractor will then provide verification that the equipment has been replaced and / or calibrated prior to proceeding with the re-starting and performance of TAB activities.

2.2 INSTRUMENTS

.1 Prior to TAB, submit 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 three (3) months of site work commencement of TAB. Calibrate every six (6) months thereafter. Have Calibration Certificates available and presentable while performing TAB.

2.3 SHIMS AND PULLEYS

.1 The contractor will provide all shims and pulleys required to achieve the standards of TAB.

PART 3 - EXECUTION

3.1 GENERAL

.1 Adjust fan speeds and modify pumps or controls as required to produce design flow.

.2 Adjust air systems for design outside air quantity, design recirculating air quantity and design exhaust air quantity.

.3 Test and record heating and cooling apparatus entering and leaving air, water and refrigerant temperatures.

.4 Adjust flow patterns from air distribution devices to minimize drafts.

.5 Verify that all controls are functioning as intended.

.6 Conduct capacity tests on all equipment. Tests to be made during a period of stable operation and minimal load fluctuation. Submit performance report for each item tested. Reports to include comparison of design capacity, installed capacity and actual operating capacity.

.7 Provide schematics with each test report identifying all components within system and position of controlling devices.

.8 Carry out final balancing under peak load conditions to suit system and outdoor conditions. Where loads cannot be simulated, final tests to be carried out at time of peak condition.

.9 Verify variable volume system/equipment performance under minimum and maximum conditions. Final tests to be carried out with controls operating.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PRE–TAB REVIEW

.1 Review contract documents before project construction is started submit report on the adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report proposed procedures which vary from standard.

.3 During construction have a minimum of 1 site visit, or 1 site visit every 40 working days to coordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

3.4 OPERATION OF SYSTEMS DURING TAB

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

.2 Identify and report failures of equipment that occur during this time.

3.5 TAB COMMENCEMENT OF SITE ACTIVITIES – ADJUSTING AND BALANCING

.1 Notify Consultant 10 working days prior to start of TAB.

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

- .1 Installation of ceilings, doors, windows, other construction affecting TAB.
- .2 Application of weather-stripping, sealing, and caulking.
- .3 Pressure, leakage, other tests specified elsewhere Division 23.
- .4 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 Equipment commissioning complete.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed volume control dampers open.

.3 Liquid Systems:

.1 Flushed, filled, vented.

.2 Equipment commissioning complete.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

.4 Control Systems:

.1 Complete and Verified.

3.6 TAB – TESTING AND PERFORMANCE VERIFICATION

.1 Perform all performance verification testing following the completion and acceptance of the balancing reports.

.2 Hydronic Systems Capacity Tests: perform hydronic system capacity tests after:

.1 TAB has been completed.

.2 Verification of operating, limit, safety controls.

.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.3 Calculate System Capacity at Test Conditions:

.1 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.2 When capacity test is completed, return controls and equipment status to normal operating conditions.

.3 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.4 Heating System Capacity Test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.2 Test Procedures:

.1 Open fully heat exchanger, heating coil and radiation control valves.

.2 Record flow rates and supply and return temperatures simultaneously.

.3 Perform tests at full load and partial load conditions.

.5 Chilled Water System Capacity Test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.2 Adding heat from building heating system or.

.3 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.

.4 Test Procedures:

.1 Open fully cooling coil control valves.

.2 Set thermostats on associated AHUs for maximum cooling.

.3 Set AHUs for design maximum air flow rates.

.4 Set load or demand limiters on chillers to 100%.

.5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

.6 Steam System Capacity Tests and Performance Verification:

.1 When systems are operational, perform relevant tests of steam and condensate return piping systems as specified under hydronic systems.

.2 Verify operation of components of steam system including:

.1 Steam traps by:

.1 Measuring temperature of condensate return and/or using audio-sensing devices.

.2 Flash tanks.

.3 Thermostatic vents.

.4 Controls.

.5 Verify performance of condensation units, including:

.1 Pump capacity at design temperature.

.2 Controls.

.3 Verify performance of condensate return system to ensure return of maximum quantity of condensate return water at with minimum temperature drop.

3.7 COMPLETION OF TAB

.1 After TAB is completed, 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.

.3 TAB is considered complete when final TAB Report received and approved by Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM E 202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

.1 In accordance with Section 20 08 02 – Commissioning, Cleaning and Start-up of Mechanical Systems.

1.3 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:
- .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
- .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
  - .1 Pump operation.
  - .2 Heat exchanger operation.
  - .3 Pressure bypass open/closed.
  - .4 Control pressure failure.
  - .5 Maximum heating demand.
  - .6 Maximum cooling demand.
  - .7 Heat exchanger failure.
  - .8 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.4 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:
- .1 TAB has been completed
- .2 Verification of operating, limit, safety controls.
- .3 Verification of primary and secondary pump flow rates.
- .4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:
- .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
  - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
  - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
- .2 Test procedures:
  - .1 Open fully heat exchanger, heating coil and radiation control valves.
  - .2 Record flow rates and supply and return temperatures simultaneously.
  - .3 Perform tests at full load and partial load conditions.

.7 Chilled water system capacity test:
- .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
  - .1 Adding heat from building heating system or;
  - .2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.
- .2 Test procedures:
  - .1 Open fully cooling coil control valves.
  - .2 Set thermostats on associated AHU's for maximum cooling.
  - .3 Set AHU's for design maximum air flow rates.
  - .4 Set load or demand limiters on chillers to 100%.
  - .5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

1.5 HUMIDIFICATION SYSTEMS

.1 In addition to procedures specified above, perform following:
- .1 Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing of Mechanical HVAC.
- .2 Verify performance of controls to provide steam quantities as indicated.

1.6 GLYCOL SYSTEMS

.1 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E 202.

1.7 STEAM SYSTEMS

.1 Performance verification:
- .1 When systems are operational, perform relevant tests of steam and condensate return piping systems as specified under hydronic systems.
- .2 Verify operation of components of steam system including:
  - .1 Steam traps by:
    - .1 Measuring temperature of condensate return and/or
    - .2 Using audio-sensing devices.
    - .3 Use of other approved methods.
  - .2 Flash tanks.
  - .3 Thermostatic vents.
- .3 Verify performance of condensation units, including:
  - .1 Pump capacity at design temperature.
  - .2 Controls.
- .4 Verify performance of condensate return system to ensure return of maximum quantity of condensate return water at with minimum temperature drop.
- .5 Adjust piping system as required to eliminate water hammer.

.2 Monitor system continuously until acceptance for proper operation of components including steam traps, thermostatic vents, flash tanks and condensate pumping units.

1.8 POTABLE WATER SYSTEMS

.1 When cleaning is completed and system filled:
- .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
- .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
- .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.9 COMPRESSED AIR SYSTEMS

.1 Verification of existing and new compressed air system to ensure capacities, pressures and functionality of system are consistent with operational requirements.

.2 Commissioning Agency: installing Contractor.

.3 Design Criteria, Design Intents: refer to Performance Verification (PV) Report Forms.

1.10 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices are specified in Division 20 and Division 23.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.

.4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.11 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

.5 Cleanouts: refer to Section 22 13 19 – Storm – Sanitary Waste Piping Specialties.

.6 Roof drains:
- .1 Refer to Section 22 13 19 – Storm – Sanitary Waste Piping Specialties.
- .2 Remove caps as required.

1.12 REPORTS

.1 In accordance with Section 01 91 01 - Commissioning: Reports, supplemented as specified herein.

1.13 TRAINING

.1 In accordance with Section 01 91 01 - Commissioning: Training of O&M Personnel, supplemented as specified herein.

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 SCOPE DESCRIPTION SUMMARY

.1 This section will describe the requirements of the ductwork installer to test the installed ductwork for leakage and system performance.

1.2 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
- .1 SMACNA HVAC Air Duct Leakage Test Manual.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 –Submittals.

.2 Test Reports: submit certified test reports indicating compliance with specifications for specified performance characteristics and physical properties.

.3 Prepare report of results and submit to Consultant within 24 hours of completion of tests. Include:
- .1 Schematic of entire system.
- .2 Schematic of section under test showing test site.
- .3 Required and achieved static pressures.
- .4 Orifice differential pressure at test sites.
- .5 Permissible and actual leakage flow rate (L/s) (Cfm) for test sites.
- .6 Witnessed certification of results.

.4 Include test reports in final TAB report.

1.4 QUALITY ASSURANCE

.1 The contractor performing the work of this section will understand the requirements of and understand the use of equipment to perform the tests.

.2 Pre-Test Meeting:
- .1 Convene pre-installation meeting prior to beginning work of this Section with Consultant.
- .2 Verify project requirements and testing objectives.
- .3 Determine the extent and expectations of when tests will be conducted during construction.

1.5 COMMISSIONING

.1 Refer to Section 01 91 01 - Commissioning.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The test apparatus will be a manufactured item, capable of performing the required tests.

2.2 TEST INSTRUMENTATION

.1 Test apparatus to include:
- .1 Fan capable of producing required static pressure.
- .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
- .3 Flow measuring instrument compatible with the orifice plate.
- .4 Calibration curves for orifice plates used.
- .5 Flexible duct for connecting to ductwork under test.
- .6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.

.3 Test instruments: calibrated and certificate of calibration available during the testing procedure. Calibration certificate will be dated no more than 6 months prior to the date of testing.

PART 3 - EXECUTION

3.1 GENERAL

.1 Perform ductwork pressure testing, progressively as construction advances. Verify construction standards are adhered to as duct sections are installed.

.2 Test ducts before installation of insulation or other forms of concealment.

.3 Test after seals have cured.

.4 Test when ambient temperature will not affect, effectiveness of seals and gaskets.

.5 Flexible connections to VAV boxes.

3.2 MANUFACTURER’S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations and instructions on the use of the testing apparatus. Including product technical bulletins, handling and storage installations.

3.3 TESTING PROCEDURES

.1 Refer to Section 23 31 00 – HVAC Ducts and Casings for duct construction standards and maximum test pressures. Perform tests at those test pressures and determine the resultant leakage. Verify the duct construction meets the duct construction seal standards specified.

.2 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

.3 Testing will commence when sufficient ductwork has been installed for the requirements of the testing apparatus. Testing will continue as construction progresses. Continuous failure of testing will result in back charging of the contractor for the commissioning agents labour for witnessing of the testing.

.4 The Consultant will determine the extent and ductwork sections to be tested. Once testing requirements have been determined, that test will be conducted within 24 hours of the request for tests.

.5 Be prepared and include costs for testing a minimum of 25% of all installed horizontal ductwork and a minimum of 50% of all installed risers (to be concealed). Failure of any testing will not constitute part of the testing percentages required herein.

.6 Maximum lengths of ducts to be tested consistent with capacity of test equipment. Section of duct to be tested to include:

.1 Fittings, branch ducts, tap-ins.

.7 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.8 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the materials and methods for the installation of hydronic HVAC distribution piping within the building, operating to 99°C (210°F) and 861 KPa (125PSI).

.2 Systems to be installed to this specification:

- .1 Hydronic Heating Piping Systems.
- .2 Hydronic Chilled Water Piping Systems.
- .3 Hydronic Glycol Heating Piping Systems.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 CSA (Canadian Standards Association):

- .1 CSA B51 – Boiler and Pressure Vessel Code.

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

- .1 ASME - Boiler and Pressure Vessel Code.
- .2 ASME/ANSI B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- .3 ASME/ANSI B16.5 - Pipe Flanges and Flanged Fittings.
- .4 ASME/ANSI B16.9 - Factory-Made Wrought Buttwelding Fittings.
- .5 ASME/ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
- .6 ASME/ANSI B16.15 - Cast Bronze Threaded Fittings.
- .7 ASME/ANSI B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .8 ASME/ANSI B16.21 – Non-metallic Flat Gaskets for Pipe Flanges.
- .9 ASME/ANSI B16.25 – Butt Welding Ends.
- .10 ASME/ANSI B16.34 - Valves - Flanged, Threaded, and Welding End.
- .11 ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions.

.4 ASTM International:

- .1 ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .2 ASTM A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- .3 ASTM A 47/A 47M - Standard Specification for Ferritic Malleable Iron Castings.
- .4 B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
- .5 ASTM E 202 - Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.5 CSA International:

- .1 CSA B242 - Groove and Shoulder Type Mechanical Pipe Couplings.
- .2 CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.6 Manufacturer's Standardization of the Valve and Fittings Industry (MSS):

Ball Valves:

.1 MSS-SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

Butterfly Valves:

.2 MSS-SP-67, Butterfly Valves.

Globe Valves:

.3 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

.4 MSS-SP-78, Grey Iron Plug Valves, Flanged and Threaded Ends.

Check Valves:

.5 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

.6 MSS-SP-71, Grey Iron Swing Check Valves Flanged and Threaded Ends.

.7 American Welding Society (AWS):

.1 AWS C1.1M/C1.1 - Recommended Practices for Resistance Welding.

.2 AWS Z49.1 - Safety in Welding, Cutting and Allied Process.

.3 AWS W1 - Welding Inspection Handbook.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 - Submittals.

.2 Product Data:

.1 Product data shall be submitted for the following:

.1 Valves.

.2 Check Valves.

.3 Strainers.

.4 Balancing Valves.

.5 Suction Diffusers.

.6 Glycol.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data shall include all relevant information to confirm the specifications have been met.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer licensed in Province of Ontario, Canada.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 The contractor performing the work of this section shall be a recognized installer of hydronic piping systems and have a minimum of five (5) years' experience which can be documented and verified.

.3 Grooved Piping System Installer: all mechanics responsible for installing grooved joint piping system to have been trained by manufacturer and retain certificate of training.

.4 Welder Qualifications:

.1 Perform welding only with certified welders suitable for class of welding required. Use welders qualified and licensed by Provincial authorities.

.2 Welders to qualify in accordance with ASTM, ANSI B31.1 and Governmental Regulations. Welder's certificate of qualification, not older than 6 months, to be on file at work site.

.3 Welding installation to be to CSA W59, latest edition.

.4 Welder to mark each weld with personal steel pencil for individual work identification. Mark each joint with stencil before radiographs are taken.

PART 2 – PRODUCTS

2.1 GENERAL

.1 The hydronic distribution system, including piping, joints, fittings, and valves shall meet or exceed the following performance characteristics:

.1 Temperature Range: -25°C to 99°C (-15°F to 210°F).

.2 Pressure Range: Maximum 690 kPa (100 PSI).

.2 Minimum services rating to be 1034 kPa (150 PSI) or system pressure, whichever is greater.

2.2 PIPE

.1 Steel Pipe:

.1 Black Steel Pipe: to ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless, Type E, Grade B Electric Resistance Weld.

.2 Black Steel Pipe: to ASTM A106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service, Type S, Grade B Seamless.

.3 NPS ½ (1/2"Ø) thru NPS 2 (2"Ø): Minimum Schedule 40/STD. Maximum Working Pressure of 2585 kPa (375 PSI) for Threaded Pipe with a Safety Factor of 8 or 0.50.

.4 NPS 2 ½ (2 ½"Ø) thru NPS 6 (6"Ø): Minimum Schedule 40/STD. Maximum Working Pressure of 3275 kPa (475 PSI) for Plain End Pipe with a Safety Factor of 8 or 0.50.

.2 Copper Tube:

.1 Copper Tubing: to ASTM B88 & B88M - Standard Specification for Seamless Copper Water Tube & Metric Version.

.2 All tubing shall be Type "K", hard drawn.

.3 NPS ½ (1/2"Ø) thru NPS 2 (2"Ø): Maximum Working Pressure of 2825 KPa (410 PSI) for Plain End Pipe with a Safety Factor of 0.50.

2.3 FITTINGS AND JOINTS

.1 Threaded Fittings – Steel Pipe:

.1 Screwed Fittings: malleable iron, Class 150.

.2 PTFE tape.

.3 Conforming to ASME/ANSI B16.3 - Malleable Iron Threaded Fittings.

.2 Welded Fittings – Steel Pipe Butt Weld:

.1 Butt-welding fittings: factory manufactured carbon steel.

.2 Conforming to ASTM A234 / A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.3 Conforming to ASME/ANSI B16.9 - Factory-Made Wrought Steel Butt Welding Fittings.

.3 Flanged Fittings – Steel Pipe:

.1 Forged Steel, Butt Weld Welding Neck Flanges Class 150: fittings shall be factory manufactured carbon steel, with raised serrated face and pre drilled to American Steel Flange Standard B16.5

.2 Conforming to ASTM A234 / A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.3 Conforming to ASME/ANSI B16.5 - Pipe Flanges and Flanged Fittings.

.4 Flange Gaskets: 1.6 mm (1/16”) thick preformed high temperature graphite sheet gasket, carbon fiber / nitrile composition. Conforming to ASME B16.21 – Non-metallic Flat Gaskets for Pipe Flanges.

.5 Bolts / Nuts: heat treated carbon steel, hexagonal to ASTM A307.

.4 Grooved Rigid Coupling / Zero Flex – Steel Pipe:

.1 Coupling to be grooved, mechanical type which engages grooved or shouldered pipe ends, encasing an internal, fully encased, gasket which bridges pipe ends to create the seal. Coupling to be cast in two or more parts secured together during assembly by nuts and bolts. Couplings to be designed with angle bolt pads to provide a rigid non flexible joint. Rolled grooved couplings (cut joints will not be permitted).

.2 Coupling shall be constructed from cast ductile iron, conforming to ASTM A 536. Coupling shall have painted enamel, corrosion resistant finish.

.3 Gaskets: shall be rated for applicable service and minimum 110°C (230°F). Gasket to be grooved mechanical type, pressure responsive to internal pressure increasing the seal tightness.

.1 EPDM Gaskets for Water Service.

.2 EPDM Gaskets for Ethylene or Propylene Glycol Service.

.4 Bolts / Nuts: heat treated carbon steel, hexagonal to ASTM A307.

.5 Soldered Fittings – Copper Pipe NPS 2 (2”Ø) and Under:

.1 Soldered or brazed joints utilizing filler material and flux.

.2 Wrought copper and copper alloy solder joint pressure fittings conforming to ANSI/ASME B16.22.

.3 Cast copper alloy solder joint pressure fittings conforming to ANSI B16.18.

.4 Cast bronze threaded fittings conforming to ANSI/ASME B16.15.

.5 Solder Filler Material: tin-antimony, 95:5: to ASME B16.18.

.6 Brazing Filler Material: Copper / Phosphorous / Silver Solder to ANSI/AWS A5.8.

2.4 DIELECTRIC UNIONS

.1 Isolate system components from galvanic currents with dielectric fittings to suit dissimilar metals.

.2 Provide isolating bronze unions for pipe sizes NPS 2 (2"Ø) and smaller, flanges with gaskets for pipe sizes NPS 2½ (2½"Ø) and larger.

.3 Unions to withstand minimum 600 V on a dry line without flashover. Dielectric fittings shall meet or exceed the operating and test pressure of the system.

2.5 VALVES GENERAL

.1 Valves: except for specialty valves, to be of single manufacturer.

.2 All gaskets and packing shall be non-asbestos.

2.6 BALL VALVES

.1 Ball Valve, Soldered End / Screwed End:
- .1 NPS 2 ½ (2 ½"Ø) and under, soldered or screwed.
- .2 Two piece forged brass body, full port, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat.
- .3 Extended brass stem for handle operation outside insulation.
- .4 Steel lever handle, with plastic coated contact surface. Provide locking handle type for lock shield service.
- .5 Class 150 WSP. With CSA and UL approval. Conforming to MSS-SP-110.

.2 Ball Valve, Grooved End:
- .1 NPS 3 (3"Ø) and over, grooved end.
- .2 Two piece forged brass body, full port, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat.
- .3 Extended brass stem for handle operation outside insulation.
- .4 Steel lever handle, with plastic coated contact surface. Provide locking handle type for lock shield service.
- .5 Class 150 WSP. With CSA and UL approval. Conforming to MSS-SP-110.

2.7 BUTTERFLY VALVES

.1 Butterfly Valves, Grooved End:
- .1 NPS 3 (3"Ø) and over, grooved end.
- .2 Cast brass body, bronze disk with elastomer seal, and stainless steel stem with EPDM seal. Steel plate drive adaptor.
- .3 Manual gear operator with round ridged handle, with PVC coated contact surface. Zinc plated nut.
- .4 Class 150 WSP. With CSA and UL approval. Conforming to MSS-SP-67.

2.8 SWING CHECK VALVES

.1 Swing Check Valve, Soldered End / Screwed End:

.1 NPS 2 ½ (2 ½"Ø) and under, soldered.

.2 Y-pattern body, all bronze construction. Cast bronze body, screw in access cap, bronze swing disk, bronze hinge and stainless steel pin.

.3 Class 150 WSP. Conforming to MSS-SP-80.

.2 Swing Check Valve, Flanged End:

.1 NPS 2 ½ (2 ½"Ø) and over, flanged.

.2 Y-pattern body, cast iron body and bolted cast iron access cap, bronze swing disk, bronze hinge and stainless steel pin. Replaceable bronze seat rings.

.3 Class 125 WSP, conforming to MSS-SP-71.

2.9 STRAINERS

.1 Y-Pattern Strainer, Soldered End / Screwed End:

.1 NPS 2 ½ (2 ½"Ø) and under, soldered or screwed.

.2 Y-pattern body, cast bronze body, screw in access cap, stainless steel removable and cleanable 20 mesh strainer. Strainer to be non-ferrous.

.2 Y-Pattern Strainer, Flanged End / Grooved End:

.1 NPS 2 ½ (2 ½"Ø) and over, flanged or grooved.

.2 Y-pattern body, cast iron body, bolted or grooved steel access cap.

.3 Stainless steel removable and cleanable 20 mesh strainer. Strainer to be non-ferrous. Free screen area not to be less than double the internal cross-sectional area of pipe.

.4 NPS ¾ (3/4"Ø) plug for blow down connection.

.3 Strainers NPS 4 (4"Ø) and greater shall be equipped with a blowdown connection. NPS ¾ (3/4"Ø) blow down pipe with ball valve and hose end connection.

.4 Strainers at pumps to be provided with magnetic screen assembly.

2.10 SUCTION DIFFUSERS

.1 Engineered flow, suction diffuser of angle body type with straightening vanes and combination diffuser-strainer-orifice cylinder.

.2 All screwed connections or flanged outlet and flanged or grooved inlet connection.

.3 Cast ductile iron body, carbon steel or cast iron flow straitening vanes. Stainless steel 3 mm (0.125") perforated strainer, with fine mesh removable start-up strainer. Bolted strainer access plate with reusable EPDM gasket. Permanent magnet in flow stream, removable for cleaning. Working Pressure: 1206 kPa (175 psi). Equipped with adjustable support foot, strainer blow down connection, pressure gauge tapings at inlet and discharge of strainer screen.

2.11 PRESSURE INDEPENDENT CONTROL VALVES

.1 All devices requiring control and / or balancing shall be complete with a pressure independent control valve supplied by Tour and Anderson or Siemens

.2 General

.1 All control valves shall be sized and provided by the controls vendor. All control valve bodies shall be suitable for the static and dynamic pressures of the system. Control valve operators shall be sized to close against a differential pressure equal to the design pump head plus 10 percent.

.2 Body pressure rating and connection type construction shall conform to fitting and valve schedules. The valve seat differential pressure rating shall exceed the pump dynamic head design pressure.

.3 All automatic control valves shall be installed by the mechanical trade.

.3 The controls contractor shall provide wiring as follows:

.1 All line voltage power for electric valve actuators shall be wired by the controls contractor from the nearest available power provided.

.2 All low voltage wiring between the controller and the valve actuator shall be wired by the controls contractor.

.4 General Construction Materials

.1 Control valve bodies shall be constructed of cast iron and shall meet requirements of ANSI 125 or ANSI 250 pressure classes

.2 Valves shall be constructed with a single chamber and multiple seats to provide flow limiting, pressure compensation and flow control.

.3 Valves shall contain a mechanical, spring-loaded pressure independent regulator to maintain a consistent differential pressure across the control port of the valve

.4 Valves shall contain an actuated flow control portion that responds to the modulating signal from the controller. This control valve portion shall have a linear flow characteristic.

.5 Valves shall contain a field adjustable flow limiter. The flow limiter shall be easily adjustable in the field without the use of special tools. The adjustment dial shall be set for and indicate maximum flow. It shall be possible to manually limit the flow to the required value with the flow limiter and then modulate the flow with the control valve and actuator.

.6 A table shall be attached to each valve indicating GPM corresponding to each setting on the dial.

.7 The valve shall always maintain full nominal stroke regardless of the maximum flow setting of the flow limiter.

.8 The flow limiter shall be lockable and tamper resistant when the actuator is installed.

.9 At any given actuator setting the flow accuracy across the entire pressure independent operating range of the automatic differential pressure regulator shall be ±10% or less

.10 Pressure ports shall be standard in the body of the valve for all flanged valves. Pressure ports shall provide a means for a balancer to test the differential pressure across the valve control port to ensure the PICV is operating within the pressure independent range.

.11 Valves 2-1/2 inch and larger line size shall meet or exceed ANSI Class IV (0 to 0.01% of nominal maximum) leakage rating at 100 psi close off.

.12 The differential pressure range for effective pressure independent operation shall be 3.6 – 90 psi or 8 – 90.

.5 Valve materials:
- .1 Valve body: Cast iron
- .2 Stem, spring: Stainless steel
- .3 Seat: Stainless steel
- .4 Plug: Brass and EPDM
- .5 Seals: EPDM
- .6 Valves 2 inch and below shall be screwed connection.
- .7 Valves 2-1/2 inch and larger shall be provided with ANSI 125 or ANSI 250 flanged connections.
- .8 Actuators shall be UL and CSA listed.

.6 Failure conditions:
- .1 Heating Valves shall fail open.
- .2 Chilled Water Coils shall fail closed.
- .3 Reheat Coils shall fail closed.
- .4 Perimeter Heating Units and fan coils shall fail open.

2.12 TRIPLE DUTY VALVES

.1 All triple duty valves shall provide three functions:
- .1 Isolation: Positive drip-tight shut-off.
- .2 Backflow: Spring-closure type silent non-slam check valve.
- .3 Balancing: flow reduction thru a throttling capability.

.2 The valve shall have four, NPS ¼ (¼"Ø) threaded brass ports with check valves and caps located two each, inlet and outlet.

.3 NPS 3 (3”Ø) and over, Flanged / Grooved End:
- .1 Valve shall be straight or angle pattern.
- .2 Ductile iron body, brass stem and bronze disc, EPDM seals. Brass fittings for metering ports.
- .3 Extended stainless steel stem for handle operation outside insulation.
- .4 Rated for a working pressure of 2068 kPa (300 psi).

.4 Valve shall be complete with preformed fiberglass insulation housing with PVC jacket.

2.13 GLYCOL FLUID

.1 Fill Glycol Systems with a glycol solution of 40% (by volume) propylene glycol complete with ortho-phosphate inhibitor and 60% (by volume) de-mineralized water.

.2 Fill system and glycol mixing tank with solution and provide spare capacity for one fill of glycol mixing tank.

2.14 PIPE EXPANSION PROVISIONS

.1 The system will be free floating system.

.2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement xx mm (xx") utilizing x number of couplings and nipples.

.3 Guides and Anchors: Locations as indicated and detailed or as proposed by contractor.
- .1 Anchors: Attachment to structure to be reviewed with and approved by the structural engineer.
- .2 Alignment guides: To accommodate specified thickness of insulation.

.4 Expansion loops: Utilize expansion loops as indicated. Where Z-bends, U-bends or pipe loop expansion arrangements are used, provide anchors and guides to direct movement along axis of joint. Guide spacing to take into consideration the column buckling strength of the pipe

.5 Bellows type expansion joints:
- .1 For axial, lateral or angular movements, as indicated.
- .2 Bellows: multiple bellows, hydraulically formed, two ply, stainless steel.
- .3 Reinforcing or control rings: 2 piece nickel iron.
- .4 Ends: flanged.
- .5 Liner: austenitic stainless steel in direction of flow.
- .6 Shroud: carbon steel, painted.

2.15 PIPE WELDING

.1 Pipe welding shall be in conformance with the AWA (American Welding association) standards.

.2 Steel Butt Weld Fittings: to ANSI B16.9, latest edition.

.3 Steel Socket Weld Fittings: to ANSI B16.11, latest edition.

.4 Electrodes: Certified by Canadian Welding Bureau to appropriate CSA W48 standard.

2.16 DRAIN VALVES AND AIR VENTS

.1 Provide drain valves at low points in system piping and manual air vents at high points in system piping. Provide automatic air vents at top of system and at point of controlled air / water separation.

.2 Drain Valves: NPS ¾ (3/4"Ø) ball valves with hose end connection.

.3 Manual Air Vents: NPS ¼ (1/4"Ø) plug valves.

.4 Automatic Air Vents: standard float type vent: brass body and NPS [1/8] connection and rated at 690 kPa (100 psi) working pressure. Equip automatic air vents with isolation valves to permit servicing without draining the system.

2.17 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1	All Valves	Kitz, Nibco
.2	Backflow Preventors	Zurn, Conbraco
.3	Vacuum Breakers	Watts, Zurn
.4	T&P Relief Valves	Watts, Conbraco
.5	Hose Bibb	Zurn, Watts
.6	Pressure Reducing Regulators	Zurn, Watts
.7	Thermometers and Pressure Gauges	Winters, Wika, Weiss
.8	Suction Diffusers / Triple Duty Valves	Armstrong, B&G, Emmerson
.9	Air Vents	Maid o Mist, Sarco
.10	Pressure Independent Control Valves	Tour and Anderson, Siemens
.11	JLR Specified Products and bases of design: Nil	

PART 3 - EXECUTION

3.1 GENERAL

.1 Comply with piping installation requirements of Section 23 05 05 – Installation of Pipe.

.2 Ream pipes, clean scale and dirt, inside and out, before and after assembly. Cap open ends of piping during installation.

.3 Grade horizontal water piping down minimum 1:700 (1" in 40'-0"). Install drain valves at all low points, manual air vents at high points.

.4 Provide screwed or flanged joints in accessible locations. Provide access doors as required.

.5 Install flanges or unions at connections to all equipment.

.6 Reduce fittings to be eccentric and installed so as not to trap air.

.7 Provide dielectric couplings for joining dissimilar metals.

.8 Use valves and strainers of same size as pipe to which they are connected, unless otherwise indicated.

.9 Valves to be accessible. Make valves removable without dismantling adjoining pipe.

.10 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.11 Make provision for thermal expansion of piping system and building structure through use of expansion joints, expansion loops and bends and appropriate supports, anchors and guides. .

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PIPE SYSTEM APPLICATION

.1 Utilize the following table to determine design operating conditions, acceptable materials and methods for different hydronic piping applications.

.2 Ensure that all personnel involved in the installation of manufacturer's products are fully conversant with the pipe end preparation, tools and requirements.

.1 Correct coupling and / or fitting selection to suit the application.

.2 Proper assembly of joints to accommodate expansion, contraction and/or flexibility as required.

.3 Adherence to specifications and/or recommendations with respect to support, anchoring and guiding of piping systems.

Piping System Application Guide					
Piping Service	**Operating Temperature**	**Maximum Operating Pressure**	**Pipe Size**	**Acceptable Pipe Material**	**Acceptable Pipe Joints**
Chilled Water or Chilled Glycol Supply and Return (Insulated)	0 °C – 24 °C (32°F – 75°F)	861 kPa (125 PSI)	≤ NPS 2 ½ (2 ½ "Ø)	Copper Steel SCH 40	Soldered, Screwed, Welded, Flanged,
			NPS 2 ½ (2 ½"Ø) to NPS 6 (6"Ø)	Steel SCH 40	Welded, Flanged (Victaulic Coupling within Mechanical Rooms)
Low Temp Heating Water or Heating Glycol Supply and Return (Insulated)	38 °C – 60 °C (100°F-140°F)	861 kPa (125 PSI)	≤ NPS 2 ½ (2 ½ "Ø)	Copper Steel SCH 40	Soldered, Screwed, Welded, Flanged,
			NPS 2 ½ (2 ½"Ø) to NPS 6 (6"Ø)	Steel SCH 40	Welded, Flanged (Victaulic Coupling within Mechanical Rooms)
High Temp Heating Water or Heating Glycol Supply and Return (Insulated)	61 °C – 99 °C (140°F-210°F)	861 kPa (125 PSI)	≤ NPS 2 ½ (2 ½ "Ø)	Copper Steel SCH 40	Soldered, Screwed, Welded, Flanged
			NPS 2 ½ (2 ½"Ø) to NPS 6 (6"Ø)	Steel SCH 40	Welded, Flanged, ((Victaulic Coupling within Mechanical Rooms)

3.4 PIPE SUPPORT

.1 Support and install piping in accordance with Section 23 05 05 – Installation of Pipe.

.2 Provide proper alignment and grade to ensure that the piping system and pipe-supporting elements are protected from excessive stress and distortion from all concurrently acting static and dynamic loads.

.3 Vertical piping: Support or anchor vertical piping at its base and provide a minimum of one intermediate clamp for every other length of pipe except on hot water risers. Clamp every length of pipe with clamps that prevent angular movement on hot water risers where tee fittings are used. Where pipe is installed with fewer or no intermediate clamps supports or anchor the base of the piping and provide sufficient guides to prevent buckling of the pipe.

.4 Provide independent support at equipment connections, concentrated equipment loads (fittings, valves, accessories, etc.), and changes in pipe direction. For grooved joint piping systems support within 600 mm (2') either side of joining coupling.

.5 In addition to the pipe supports identified above, refer to the following schedule for minimum hanger spacing for straight length of piping.

Pipe Size	Maximum Support Spacing Copper Piping	Maximum Support Spacing Sch 40 Steel Piping
NPS ½ (1/2"Ø) - NPS ¾ (3/4"Ø)	1.5 M (5')	2.1 M (7')
NPS 1 (1"Ø) - NPS 1 ½ (1 1/2"Ø)	1.8 M (6')	2.1 M (7')
NPS 2 (2"Ø)	2.4 M (8')	3.0 M (10')
NPS 2 ½ (2 ½"Ø)	2.7 M (9')	3.3 M (11')
NPS 3 (3"Ø)	3.0 M (10')	3.6 M (12')
NPS 4 (4"Ø)	3.6 M (12')	4.2 M (14')
NPS 6 (6"Ø)		4.8 M (16')
NPS 8 (8"Ø)		5.5 M (18')
NPS 10 (10"Ø)		6.7 M (22')
NPS 12 (12"Ø)		6.7 M (22')

3.5 VALVING

.1 Provide valve type as indicated on drawings. Where not indicated, provide valving in accordance with the following where "R" refers to Required / Recommended and "A" refers to Acceptable Alternate:

Piping Valve Application Guide													
		Isolation		Balancing & Isolation					Balancing				
Service / Application		Ball Valve	Butterfly Valve	PIC Valve		Check Valve	Strainer	Suction Diffuser	Balancing Globe Valve	Calibrated Globe Valve	Triple Duty Valve	Notes:
Heating Pump <NPS 3 (3"Ø) Line Size	Inlet	**R**						**R**				
	Outlet	**R**									**R**	
Heating Pump ≥NPS 3 (3"Ø) Line Size	Inlet		**R**					**R**				
	Outlet		**R**								**R**	
AHU Coils	Inlet	**A**	**A**	**R**			**R**					
	Outlet	**A**	**A**									
Equipment	Inlet	**A**	**A**	**R**								
	Outlet	**A**	**A**									
Fan Coils Baseboard Htr Convectors Unit Heaters <NPS 2 (2"Ø) Line Size	Inlet	**R**		**R**								
	Outlet	**R**										
Control Valves with Bypass	Inlet	**A**	**A**	**R**			**R**					
	Outlet	**A**	**A**									
Control Valve Bypass		**A**	**A**									
Branch Piping / Risers		**A**	**A**									
Flow Maintenance, End of Line Bypass										**R**		

3.6 SPECIFIC INSTALLATION REQUIREMENTS

.1 Valve Installation:

.1 Install isolation valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.2 Install swing check valves in horizontal lines or provide spring operated check valves where flow direction is down.

.3 Install chain operators on valves NPS 4 (4"Ø) and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.

.2 Circuit Setter Valves:

.1 The valve shall be installed with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided.

.2 Remove handwheel after installation and when TAB is complete.

.3 Install Manufacturer's pre formed insulation and secure and tape joints in prefabricated insulation.

3.7 PIPE WELDING

.1 General:

.1 Identify each weld with welder's identification symbol.

.2 Equip welders with fire extinguishers. Observe necessary fire prevention precautions such as shields to minimize fire risk.

.2 Welding:

.1 Use only piping with machine bevelled ends for welded runs. Machine bevel pipe and fitting ends. If machining is impractical, prepare ends by grinding or by flame cutting and subsequent grinding back 3 mm (1/8") prior to welding. Clean each joint internally, swab and remove scale, surface cracks, oil, grease, oxides or other foreign matter.

.2 Make welds full penetration, continuous and without defects. Clean each layer of weld to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer. Weld reinforcement to be not less than 1.6 mm (1/6") and not more than 3 mm (1/8") above normal surface of jointed sections. Crown reinforcement at centre and merge into base material without excessive shoulder on undercut.

.3 Welding Inspection:

.1 Make work available at any time for inspection. Cover or insulate welds only after inspection carried out.

.2 Contractor shall engage an experienced firm specialized in radiography to Gamma-ray radiograph and perform these inspections on 5% of welded joints in low pressure hot and cold water systems. Radiograph welded joints over full circumference. The selection of the welds to be inspected shall be done by the Consultant.

.3 Perform radiography in accordance with Article 3 of Section 5 of the ASME Boiler and Pressure Vessel Code and CGSB-48-CP-2. Include all costs in this contract.

.4 Cut out and replace welds of poor or doubtful quality with satisfactory welds.

.5 One or more of the following defects to cause rejection of weld:

.1 Failure to meet radiographic requirements or other code tests.

.2 Welding performed by unqualified personnel.

.3 Welds not reasonably uniform in appearance.

.4 Evidence of peening.

.5 Cracks.

.6 Oxidation around welds.

.7 Lack of fusion.

.8 Presence of porosity, slag inclusion of overlaps.

.9 Undercutting adjacent to completed welds or evidence of undercutting by grinding.

3.8 PIPING SYSTEM TESTING

.1 Piping systems may be tested in whole or partial systems; however, all piping systems shall be subjected to testing.

.2 Contractor to complete installation inspection, integrity (pressure, leak) tests and support system inspection before system is insulated, concealed, or covered in any way. Piping not to be covered until all inspection and testing deficiencies have been corrected and successful re-testing has been complete.

.3 Coordinate with authority having jurisdiction the requirement of the authority to witness tests and inspect piping system.

.4 Isolate any equipment not capable of withstanding test pressure. Equipment shall be isolated from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against the test pressure without damage to valve. Blind flanges shall be installed to isolate equipment.

.5 Safety valves shall be set at a pressure no more than one-third higher than the test pressure to protect against damage by expanding liquid or other source of overpressure during test.

.6 During testing, expansion tanks shall be isolated from the system.

.7 Verify that hydronic system is full of water before starting the test. Allow water to reach ambient temperature prior to initiating the test procedures.

.8 The hydronic piping system shall be subjected to hydrostatic test pressure that is not less than 1.5 times the system's working pressure or 861 kPa (125 PSI) whichever is greater. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in system under test.

.9 After hydrostatic test pressure has been applied for at least 10 minutes, the piping, joints, and connections shall be examined for leakage. Leaks shall be eliminated by tightening, repairing, or replacing components. The hydrostatic test shall be repeated until there are no leaks.

.10 Maintain test pressure for four (4) hours without drop in pressure.

.11 Contractor to complete installation inspection, integrity (pressure, leak) tests and support system inspection before system is insulated or enclosed. Piping not to be covered until all inspection and testing deficiencies have been corrected and successful retesting has been completed.

3.9 FLUSHING AND CLEANING

.1 All heating and cooling piping systems shall be cleaned and flushed in accordance with the procedures provided by the University’s approved water treatment supplier prior to operation, and before being connected to the University’s distribution system.

.2 Provide temporary pump and all necessary equipment for flushing system.

.3 Flush out after pressure test for a minimum of four (4) hours.

.4 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.

.5 Drain and flush for two (2) hours. Remove and clean strainers.

.6 Provided all work is complete, remove construction strainer baskets and replace with operational strainer baskets.

.7 Refill system with glycol or clean water adding water treatment as specified.

3.10 FLOW BALANCING

.1 In accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC for applicable procedures.

.2 Balance water systems to within plus or minus 5 % of design flow.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the specialties to be installed with the installation of the hydronic HVAC distribution piping within the building.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 Canadian Standards Association (CSA International):
- .1 CSA B51 - Boiler, Pressure Vessel, and Pressure Piping Code.

.3 American Society of Mechanical Engineers (ASME):
- .1 ASME B40.100 - Pressure Gauges and Gauge Attachments.
- .2 ASME B40.200 - Thermometers, Direct Reading and Remote Reading.

.4 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB-14.4 - Thermometers, Liquid-in-Glass, Self-Indicating, Commercial/Industrial Type.

.5 University of Guelph Metering Standard (15930).

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 - Submittals.

.2 Product Data:
- .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data shall include all relevant information to confirm the specifications have been met.
- .5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e.; equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
- .7 Product data shall include information as specified in Section 20 01 01 - Common Work Results – Mechanical Submittals unless modified with additional information required below.

.3 Maintenance Data:
- .1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 00– Closeout Procedures.

.2 Maintenance data shall include but not be limited to:
  .1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.
  .2 The manufacturer's maintenance and installation data.
  .3 Safety informational data for maintenance staff prior to performing maintenance requirements.
  .4 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

1.4 MAINTENANCE REQUIREMENTS

.1 The Contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Where applicable equipment shall bear a ULC or UL label.

PART 2 – PRODUCTS

2.1 GENERAL

.1 The hydronic distribution system, including specialties shall meet or exceed the following performance characteristics:
  .1 Temperature Range: -25°C to 99°C (-15°F to 210°F).
  .2 Pressure Range: Maximum 690 kPa (100 PSI).

.2 Minimum services rating to be 1034 kPa (150 PSI) or system pressure, whichever is greater.

2.2 EXPANSION TANKS

.1 Expansion Tanks – Replaceable Diaphragm Type:
  .1 Provide steel pressurized diaphragm type expansion tank with diaphragm compatible with operating fluid. Tank to be ASME certified. Provide vertical tanks as indicated and/or scheduled.
  .2 Pre-charge tank to 83 kPa (12 PSI).
  .3 Elastomer Butyl / EPDM diaphragm to be replaceable and suitable for 116°C (240°F) operating temperature.
  .4 Provide all saddles and/or straps as required to meet the installation requirements.
  .5 Provide pressure gauge, air-loading Schrader valve with stop, and bottom drain connection.

2.3 AIR SEPARATORS

.1 Cyclonic Air Separator:
- .1 Provide centrifugal type air separator with strainer.
- .2 Unit to be fabricated of steel to ASME ratings for 860 KPa (125 PSI).
- .3 Unit to have flanged or grooved inlet and outlet connections and separate top connection for venting and bottom connection for blowdown.

2.4 MAKE-UP WATER AND WATER FILL ASSEMBLY

.1 Make up water assembly shall consist of a NPS 1 ¼ (1 1/4"Ø) main water line with isolation ball valve and NPS 1 ¼ (1 ¼"Ø) reduced pressure principle backwater valve. Downstream will be a tee connection to a NPS 1 ¼ (1 1/4"Ø) bypass around a pressure reducing valve. The bypass will be equipped with an isolation lock shield ball valve with the handle removed. The pressure reducing valve shall be NPS ¾ (3/4"Ø) with isolation ball valves on the inlet and outlet. The discharge of the assembly shall be equipped with a pressure gauge and a temperature and pressure relief valve.

2.5 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTERS

.1 General: Backflow Preventers shall comply with CSA B64 SERIES-11 - Backflow Preventers and Vacuum Breakers.

.2 The assembly shall also include two quarter turn ball vales for isolation at the inlet and outlet, one strainer downstream of inlet ball valve, two in-line independent check valves with an intermediate relief valve, four test cocks and an air gap drain fitting.

.3 Construction:
- .1 All components shall be lead free cast copper or cast bronze body construction.
- .2 Silicone rubber disc material in the first and second check plus the relief valve. Replaceable polymer check seats for first and second checks. Removable stainless steel relief valve seat. Stainless steel cover bolts.
- .3 Air gap drain fitting shall be cast bronze.

2.6 PRESSURE REDUCING REGULATORS

.1 General: domestic water pressure reducing regulators shall comply with CSA B356 Water pressure reducing valves for domestic water supply systems.

.2 Capacity: maximum inlet pressure: 1034 kPa (150 PSI), outlet pressure of 172 kPa (25 PSI) to 518 kPa (75 PSI) field adjustable.

.3 Construction: lead free, cast bronze body and bell, stainless steel seat, stem, and sleeve, stainless steel strainer screen, EPDM seals. Soldered inlet and outlet connections.

.4 Pressure gauges on inlet and discharge.

2.7 TEMPERATURE AND PRESSURE RELIEF VALVES

.1 General: valve shall be ASME rated and CSA listed.

.2 Pressure relief valves shall be selected for the appropriate application and exceed the required relief flow capacity. Pressure relief valves shall be provided as indicated and specified, and as required protecting the system from excessive pressure. Valves shall be complete with an extension thermostat for temperature monitoring and a test lever for periodic testing.

.3 Construction: main valve body cast brass or bronze, stainless steel internal components, silicone seals, stainless steel springs, copper encased thermostat probe.

.4 Pressure – Temperature Settings:
- .1 Temperature relief 99°C (210°F);
- .2 Pressure range 517 – 1034 kPa (75 – 150 PSI);
- .3 Determine application pressure relief setting prior to installation.

2.8 GLYCOL MAKE-UP / FILL SYSTEM

.1 Provide prefabricated, automatic standalone glycol make-up package, including glycol tank, stand, pump, wiring, piping, valves and controls.

.2 Glycol tank to be of 190 L (50 Gal) constructed from stainless steel, capable of operating with 115 °C (240 °F) internal fluid temperature without leaking or deforming. Tank shall be complete with lid with hinged access.

.3 Pumping assembly to consist of a positive displacement gear pump capable of 13 Lit/m (3.6 gpm) at 690 kPa (100 PSI) discharge pressure, with a 1/2 hp, 120V / 1 Phase electric pump. Inlet to pump shall be equipped with an isolation valve and strainer on inlet connection to tank. Discharge to be equipped with check valve, pressure switch, pressure relief valve (piped back to tank), pressure gauge, and an isolation valve. All components to be metal and rated for high temperature fluid.

.4 Unit to be complete all piping and fittings to provide a complete system. Unit to be pre wired and complete with a magnetic starter with indicator lights for running and powered.

.5 Controls to consist of high-pressure cut-off alarm, low level alarm and automatic fill system based on pressure switch.

.6 Complete unit shall be factory assembled and mounted on a steel support legs with an exterior red primer finish.

2.9 PUMP FLEXIBLE CONNECTION

.1 Application: to suit motion.

.2 Minimum Length: 150 mm (6”) or in accordance with manufacturer's recommendations to suit offset. Inner hose: bronze corrugated. Braided wire mesh bronze outer jacket. Flanged connections.

.3 Operating Conditions: To match system requirements.

2.10 VACCUUM BREAKERS

.1 Vacuum Breaker: brass vacuum breaker adjustable to control induced vacuum with range of 62 to 4980 Pa (¼" to 20" w.g.) vacuum complete with swing check valves. Factory preset at 500 Pa (2" w.g.).

2.11 PRESSURE GAUGES

.1 Pressure Gauges: 112 mm (4 ½") round dial type, stainless steel bourdon tube having 0.5% accuracy, black aluminum case with glass dial cover. Movement to be brass rotary type with bronze bushings. Equip gauges with dial face zero reset screw.

.2 Scale: black embossed figures on white background indicating dual kPa and PSI pressures. Providing a 0 to 700 kPa (0 to 100 PSI) range with 50 kPa (1 PSI) increments.

.3 Provide bronze needle valve for isolation.

2.12 THERMOMETERS

.1 Thermometers: industrial type, adjustable angle, with 225 mm (9") molded polyester case and brass stem, non-mercury filled with coloured indication.

.2 Scale: black embossed figures on white background indicating dual Fahrenheit and Celsius temperatures. Providing a -1 to 115 °C (30 to 240 °F) range with 1°C (2°F) increments.

.3 Provide stainless steel thermometer wells filled with heat conductive paste.

2.13 ENERGY METER

.1 Chilled water meter electrode shall be constructed of stainless steel.

.2 Units provided with a local digital display with tonnes and digital 4-20mA output to tie into the University of Guelph building automation system.

.3 Provide inline electronic magnetic meter, complete with proper grounding, temperature sensors, metering flow computer with display, and warranty.

.4 To use polyurethane sensor liner.

.5 The temperature sensors must be supplied on both supply and return lines, supplying a 4-20mA output signal. Temperature sensors must be properly orientated and verified for accuracy. Output of temperature and meter must be combined to display units required. The meter body shall include grounding and empty pipe electrodes of the same material as the measuring electrodes.

.6 Meter must be H.A.R.T. compatible.

.7 The magnetic flowmeter shall be microprocessor based with integral electronics.

.8 LCD display shall enable the operator to monitor flow rate in clear text messages.

.9 The meter shall have field replaceable sensors and coils

.10 The magnetic flowmeter shall provide an accuracy of +/- 0.5% of flow rate.

.11 It should be possible to check the functionality and verify deviation of the flow meter without needing to dismantle the device by using an external device. This Verification of transmitter electronics should be traceable to NIST or equivalent standards.

2.14 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 All Valves	Kitz, Nibco
.2 Expansion Tanks	Amtrol, B&G, Armstrong
.3 Air Separators	Amtrol, B&G, Armstrong
.4 Backflow Preventors	Zurn, Conbraco
.5 Pressure Reducing Regulators	Zurn, Watts
.6 Vacuum Breakers	B&G, Spirax Sarco, Cashamce
.7 T&P Relief Valves	Watts, Conbraco
.8 Glycol make up / fill systems	Suez
.9 Thermometers and Pressure Gauges	Winters, Wika, Weiss
.10 Energy Meters	Endress & Hauser, Rosemount, Spirax Sarco
.11 Air Vents	Maid o Mist, Sarco
.12 Pressure Independent Control Valves	Tour and Anderson, Siemens

.3 JLR Specified Products and bases of design:

.1 Flexible Connections	Flexonics

PART 3 - EXECUTION

3.1 GENERAL

.1 Comply with piping installation requirements of Section 20 05 05 – Installation of Pipe.

.2 Provide screwed or flanged joints in accessible locations. Provide access doors as required.

.3 Install flanges or unions at connections to all equipment.

.4 Provide clearance for installation of insulation and access for maintenance of equipment, valves, fittings.

.5 Run drain lines and blow off connections to terminate above nearest drain.

.6 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 EQUIPMENT SPECIFIC INSTALLATION REQUIREMENTS

.1 Expansion Tanks:
- .1 Floor mounted vertical expansion tanks shall be mounted on a housekeeping pad.
- .2 Provide saddles as required for horizontal expansion tank mounting.
- .3 Adjust expansion tank pressure to suit design criteria.
- .4 Install lock shield type ball valve at inlet to tank.

.2 Backflow Preventers:
- .1 Pipe overpressure discharge thru indirect drain connection to drain.

.3 Pressure Relief Valves:
- .1 Pipe discharge to drain. Piping not to rise to create liquid pockets.

.4 Glycol Fill System:
- .1 Fill system with specified glycol, and leave tank ¾ full following commissioning.
- .2 Adjust operating pressure set points and safety relief valve set points.

3.4 PRESSURE GAUGE INSTALLATIONS

.1 Install so they can be easily read from floor or platform.

.2 Install between equipment and first fitting or valve.

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

.4 Provide isolation needle valves to isolate pressure gauge for servicing.

.5 Install single gauge on pipe manifold, serving the following functions:
- .1 Suction and discharge of pumps and strainers.

.6 Install single gauges in following locations:
- .1 Upstream and downstream of PRV's.
- .2 Upstream and downstream of primary control valves.
- .3 Inlet and outlet of heat exchangers.
- .4 Outlet of expansion tank
- .5 In other locations as indicated.

3.5 THERMOMETER INSTALLATIONS

.1 Install so they can be easily read from floor or platform.

.2 Install between equipment and first fitting or valve.

.3 Use extensions where thermometers are installed through insulation.

.4 Install in wells on piping. Provide heat conductive material inside well.

.5 Install in the following locations:
- .1 Inlet and outlet of heat exchangers.
- .2 Inlet and outlet of water heating and cooling coils.
- .3 In other locations as indicated.

.6 Install wells as indicated only, for balancing purposes.

3.6 ENERGY METER INSTALLATION

.1 Install as per University Metering Standard and instructions and guidelines

.2 Install Steam Meter and Chilled Water Energy Meter as indicated..

.3 All meter location must be accessible and located in a position that allows ease of maintenance and removal without interfering with the meter accuracy or installation practices.

.4 Meter shall be installed with proper orientation, up and down stream distances and proper grounding as per manufacturer.

.5 Provide all upstream and downstream minimum distances as specified by supplier.

.6 To make good on all surroundings after completion of installation of meter.

.7 Provide insulation by approved sub-contractor to include meter body, surrounding flanges and unions.

.8 Meters, valves, and bypasses should be supported with appropriate adjustable pipe stands. bricks, concrete or wood blocking are not acceptable means of support.

.9 Meter installations must be checked for leakage or contaminants at completion of the installation, the proper operation of the meter should be established.

.10 All flange connections must be supplied with an asbestos-free gasket material top meet temperature and pressure for service.

.11 All documentation and related work shall be provided for the flow rate specified, commissioning, calibration, verification, performance specification and warranty related to the metering device.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the pumps required for the operation of hydronic HVAC piping systems within the building, operating to 121°C (250°F) and 1207 kPa (175 psi).

.2 Pumping applicable to:
- .1 Hydronic Heating Piping Systems.
- .2 Hydronic Glycol Piping Systems.

1.2 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

.2 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE):
- .1 Standard 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings.

.3 Canadian Standards Association (CSA International):
- .1 CSA-B214 - Installation Code for Hydronic Heating Systems.

.4 National Electrical Manufacturers' Association (NEMA):
- .1 NEMA MG 1 - Motors and Generators.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data will include all relevant information to confirm the specifications have been met.
- .5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
- .7 Product data will include any relevant information that Division 25 requires for a properly functioning building automation system.
- .8 Product data will include information as specified in Section 20 01 01 – Common Work Results for Mechanical unless modified with additional information required below.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.

.2 Maintenance data will include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer's maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.4 MAINTENANCE REQUIREMENTS

.1 Contractor will verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 Contractor will supply the following materials to site just prior to substantial being awarded.

.1 Provide one replacement filter for each installed filter.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment will bear a CSA label or have an ESA certification.

.3 Where applicable equipment will bear a ULC or UL label.

.4 Provide and construct mock-ups in accordance with Section 01 45 01 – Quality Control.

1.6 COMMISSIONING

.1 General: in accordance with Sections 01 91 01 – Commissioning, 20 08 02 – Commissioning – Cleaning and Start-up of Mechanical Systems.

.2 In accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The hydronic pumping system, will meet or exceed the following performance characteristics:
- .1 Temperature Range: -25°C to 121°C (-15°F to 250°F).
- .2 Pressure Range: maximum 690 KPa (100 psi).

.2 Minimum services rating to be 1207 kPa (175 psi) or system pressure, whichever is greater.

.3 All pumps will be equipped with metal impellors. Non-metal impellors will not be acceptable.

.4 Distribution pumps will be duplex, arranged in parallel and each pump capable of 100% of the system capacity.

2.2 IN-LINE CENTRIFUGAL PUMPS

.1 The pump (s) will be in line type, close coupled, single stage design. Pumps will be capable of mounting in the vertical position. Provide pumps in accordance with scheduled performance criteria.

.2 Pump will be rated for a minimum of 1207 kPa (175 PSI) working pressure. The housing will be hydrostatically tested to 150% maximum working pressure.

.3 Construction:
- .1 Volute and Frame Casing: cast ductile iron construction, with flanged inlet and discharge with integrally cast support. Suction and discharge will be provided with drilled and tapped seal vent and pressure gauge connections. Casing will be radially split to allow for removal of the rotating element without disturbing pipe connections.
- .2 Impellor: impeller will be machined cast bronze, enclosed type, statically and hydraulically balanced. Impeller will be keyed to the shaft and secured by a hex head impeller nut and washer.
- .3 Pump Shaft: alloy steel shaft with bronze sleeve bearing.
- .4 Seals: mechanical shaft seals for leak less operation. Seal will be internally flushed and a portion of the pumped liquid will be utilized to lubricate and cool the seal faces.
- .5 Fittings: provide vent, and gauge connections.

.4 Motor: motor will be premium-efficiency squirrel cage induction type motors and suitable for across-the-line (wye-delta, part wind) starting. Motors will also be capable of invertor duty and variable speed operation. The motor will be TEFC (totally enclosed, fan cooled), meet NEMA specifications and will be the RPM, size (HP), and voltage as indicated. Pump and motor will be factory aligned, and verified by the contractor following installation and realigned if required.

.5 Variable Frequency Drive (VFD) to be provided by the manufacturer listed in Section 2.3 of this specification.

.6 Each pump will be factory tested and painted with at least one coat of high-grade machinery enamel prior to shipment.

2.3 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 In-line Pumps — Armstrong

.2 Variable Frequency Drives — ABB or Danfoss

.3 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 GENERAL

.1 Install hydronic pumps to CSA-B214.

.2 Pumps will be fed from the building's dedicated Essential Power System.

.3 In-line Circulators:

.1 Support at inlet and outlet flanges or unions.

.2 Install with bearing lubrication points accessible.

.4 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PUMP START-UP

.1 Procedures:

.1 Before starting pump, check that hydronic system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper, rotation and safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run-in pumps for 12 continuous hours minimum.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the materials and methods for the installation of steam heating and steam process piping within the building for operating pressures up to 865 KPa (125 PSI).

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 CSA (Canadian Standards Association)

- .1 CSA B51 – Boiler and Pressure Vessel Code.

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

- .1 ASME, Boiler and Pressure Vessel Code.
- .2 ASME/ANSI B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- .3 ASME/ANSI B16.5 - Pipe Flanges and Flanged Fittings.
- .4 ASME/ANSI B16.9 - Factory-Made Wrought Buttwelding Fittings.
- .5 ASME/ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
- .6 ASME/ANSI B16.15 - Cast Bronze Threaded Fittings.
- .7 ASME/ANSI B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .8 ASME/ANSI B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
- .9 ASME/ANSI B16.25 - Buttwelding Ends.
- .10 ASME/ANSI B16.34 - Valves - Flanged, Threaded, and Welding End.
- .11 ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions.

.4 ASTM International

- .1 ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- .2 ASTM A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- .3 ASTM A 47/A 47M - Standard Specification for Ferritic Malleable Iron Castings.
- .4 B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
- .5 ASTM E 202 - Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.5 CSA International

- .1 CSA B242 - Groove and Shoulder Type Mechanical Pipe Couplings.
- .2 CSA W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.6 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)

- .1 MSS SP-92 - MSS Valve User Guide
- .2 Gate Valves:
  - .1 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
  - .2 MSS-SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.

.3 Ball Valves:
  .1 MSS-SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
.4 Butterfly Valves
  .1 MSS-SP-67, Butterfly Valves.
.5 Globe Valves
  .1 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
  .2 MSS-SP-85, Gray Iron Globe & Angle Valves Flanged and Threaded Ends
.6 Plug Valves
  .1 MSS-SP-78, Gray Iron Plug Valves, Flanged and Threaded Ends
.7 Check Valves
  .1 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
  .2 MSS-SP-71, Gray Iron Swing Check Valves Flanged and Threaded Ends.

.7 American Welding Society (AWS)
  .1 AWS C1.1M/C1.1 - Recommended Practices for Resistance Welding.
  .2 AWS Z49.1 - Safety in Welding, Cutting and Allied Process.
  .3 AWS W1 - Welding Inspection Handbook.

.8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.9 Material Safety Data Sheets (MSDS).

.10 20 05 06 – Valves.

.11 University of Guelph Metering Standard (15930).

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 -–Submittals.

.2 Product Data:
  .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
  .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
  .3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
  .4 Product data shall include all relevant information to confirm the specifications have been met.
  .5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e.; equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
  .6 Product data shall identify all ancillary field installed devices and provide all information required for the co-ordination of the installation with other trades.
  .7 Product data shall include any relevant information which Div 25 requires for a properly functioning building automation system.
  .8 Product data shall include information as specified in 20 01 01 -Common Work Results Mechanical unless modified with additional information required below.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 00 – Closeout Procedures.

.2 Maintenance data shall include but not be limited to;

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer's maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 The contractor shall supply the following materials to site just prior to substantial being awarded.

.1 Provide ten replacement cover gaskets for each type and size of installed steam trap.

1.5 QUALITY ASSURANCE

.1 Performance Requirements defined: Catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical Equipment shall bear a CSA label or have an ESA certification.

.3 Welder Qualifications

.1 Perform welding only with certified welders suitable for class of welding required. Use welders qualified and licensed by Provincial authorities.

.2 Welders to qualify in accordance with ASTM, ANSI B31.1 and Governmental Regulations. Welder's certificate of qualification, not older than 6 months, to be on file at work site.

.3 Welding installation to be to CSA W59, latest edition.

.4 Welder to mark each weld with personal steel pencil for individual work identification. Mark each joint with stencil before radiographs are taken.

.5 Radiography to be provided by experienced specialist approved by Consultant.

.4 Provide and construct mock-ups in accordance with Section 01 45 01 – Quality Control.

1.6 COMMISSIONING

.1 Refer to 01 91 01- Commissioning for requirements.

.2 Refer to 20 08 02 – Commissioning – Cleaning and Start-up of Mechanical Systems.

.3 The manufacturer and/or their factory representative shall participate in the commissioning process. The manufacturer shall inspect the final installation and verify that the product has been installed as per the manufacturer's instructions. The manufacturer shall report compliance or discrepancies directly to the Consultant.

1.7 TRAINING

.1 The manufacturer and/or their factory representative shall participate in the training process. The manufacturer shall provide factory trained and approved instructional personnel for both classroom and on-site training as indicated.

PART 2 – PRODUCTS

2.1 GENERAL

.1 Select all components for 1035 KPa (150 PSI) system rating.

2.2 PIPE

.1 Steam and Condensate Piping - Steel Pipe

- .1 Black Steel pipe: to ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless, Type E, Grade B electric resistance weld
- .2 Black Steel pipe: to ASTM A106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service, Type S, Grade B seamless.
- .3 Steam Piping: Minimum Schedule 40/STD. Maximum working Pressure of 2585 KPa (375 PSI) for threaded pipe with a safety factor of 8 or 0.50.
- .4 Condensate Piping: Minimum Schedule 80/STD.

2.3 FITTINGS AND JOINTS

.1 Threaded Fittings – Steel Pipe

- .1 Screwed fittings: malleable iron, Class 150.
- .2 PTFE tape.
- .3 Conforming to ASME/ANSI B16.3 - Malleable Iron Threaded Fittings

.2 Welded Fittings – Steel Pipe Butt Weld

- .1 Butt-welding fittings: factory manufactured carbon steel.
- .2 Conforming to ASTM A234 / A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .3 Conforming to ASME/ANSI B16.9 - Factory-Made Wrought Steel Butt-welding Fittings

.3 Flanged Fittings – Steel Pipe

.1 Forged Steel, Butt Weld Welding Neck Flanges Class 150. Fittings shall be factory manufactured carbon steel, with raised serrated face and pre drilled to American Steel Flange Standard B16.5

.2 Conforming to ASTM A234 / A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.3 Conforming to ASME/ANSI B16.5 - Pipe Flanges and Flanged Fittings.

.4 Flange Gaskets: 1.6 mm (1/16") thick preformed high temperature graphite sheet gasket, carbon fiber / nitrile composition. Conforming to ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.

.5 Bolts / Nuts: Heat treated carbon steel, hexagonal to ASTM A307.

2.4 PIPE WELDING

.1 Pipe welding shall be in conformance with the AWA (American Welding association) standards.

.2 Steel butt weld fittings: to ANSI B16.9, latest edition.

.3 Steel socket weld fittings: to ANSI B16.11, latest edition.

.4 Electrodes: Certified by Canadian Welding Bureau to appropriate CSA W48 standard.

2.5 EXPANSION PROVISIONS

.1 The system will be free floating system.

.2 Guides and Anchors: Locations as indicated and detailed or as proposed by contractor.

.1 Anchors: Attachment to structure to be reviewed with and approved by the structural engineer.

.2 Alignment guides: To accommodate specified thickness of insulation.

.3 Expansion loops: Utilize expansion loops as indicated. Where Z-bends, U-bends or pipe loop expansion arrangements are used, provide anchors and guides to direct movement along axis of joint. Guide spacing to take into consideration the column buckling strength of the pipe.

2.6 VALVES

.1 General

.1 Valves: Except for specialty valves, to be of single manufacturer.

.2 All gaskets and packing shall be non-asbestos.

.3 Refer to 20 04 01 Mechanical Identification for Valve tag and identification requirements

.2 Gate Valve NRS, Soldered / Screwed End:

.1 NPS 2 (2"Ø) and under, soldered / screwed:

.2 Non Rising Stem style, full port flow, all bronze construction. Cast bronze body, screw in cast bronze bonnet, bronze stem, and solid bronze wedge disc. Adjustable PTFE packing.

.3 Aluminum round ridged handle, with PVC coated contact surface. Zinc plated handle nut.

.4 Class 150 WSP. Conforming to MSS-SP-80.

.3 Gate Valve NRS, Flanged End:

.1 NPS 2 ½ (2 ½"Ø) and over, flanged:

.2 Non Rising Stem style, full port flow with full length disc guides. Cast iron body, multiple bolt, bolted cast iron bonnet, bronze stem, and solid cast iron wedge disc with renewable bronze seat rings. Adjustable PTFE packing.

.3 Cast Iron round ridged handle. Zinc plated handle nut.

.4 Class 125 WSP. Conforming to MSS-SP-70.

.4 Globe Valve, Soldered End / Screwed End:

.1 NPS 2 ½ (2 ½"Ø) and under, soldered or screwed:

.2 Rising Stem style, all bronze construction. Cast bronze body, screw in cast bronze bonnet, bronze stem, and bronze disc holder. PTFE disc. Adjustable PTFE packing.

.3 Aluminum round ridged handle, with PVC coated contact surface. Zinc plated handle nut.

.4 Class 150 WSP. Conforming to MSS-SP-80.

.5 Globe Valve RS OS&Y (Outside Screw and Yoke), Flanged End:

.1 NPS 2 ½ (2 ½"Ø) and over, Flanged:

.2 Rising Stem style, cast iron body, multiple bolt, bolted cast iron bonnet, bronze stem, and bronze disk. Renewable bronze seat ring. Adjustable PTFE packing.

.3 Cast Iron round ridged handle. Zinc plated handle nut.

.4 Class 125 WSP. Conforming to MSS-SP-85.

2.7 CHECK VALVES

.1 Swing Check Valve, Soldered End / Screwed End:

.1 NPS 2 ½ (2 ½"Ø) and under, soldered:

.2 Y Pattern body, all bronze construction. Cast bronze body, screw in access cap, bronze swing disk, bronze hinge and stainless steel pin.

.3 Class 150 WSP. Conforming to MSS-SP-80.

.2 Swing Check Valve, Flanged End:

.1 NPS 2 ½ (2 ½"Ø) and over, flanged:

.2 Y Pattern body, cast iron body and bolted cast iron access cap, bronze swing disk, bronze hinge and stainless steel pin. Replaceable bronze seat rings.

.3 Class 125 WSP. Conforming to MSS-SP-71.

2.8 STRAINERS

.1 Y-Pattern Strainer, Soldered End / Screwed End:

.1 NPS 2 ½ (2 ½"Ø) and under, soldered or screwed:

.2 Y Pattern body, cast bronze body, screw in access cap, stainless steel removable and cleanable 20 mesh strainer. Strainer to be non-ferrous.

.2 Y-Pattern Strainer, Flanged End / Grooved End:

.1 NPS 2 ½ (2 ½"Ø) and over, flanged or grooved:

.2 Y Pattern body, cast iron body, bolted or grooved steel access cap.

.3 Stainless steel removable and cleanable 20 mesh strainer. Strainer to be non-ferrous. Free screen area not to be less than double the internal cross-sectional area of pipe.

.4 NPS ¾ (3/4"Ø) plug for blow down connection.

.3 Strainers NPS 4 (4"Ø) and greater shall be equipped with a blowdown connection. NPS ¾ (3/4"Ø) blow down pipe with ball valve and hose end connection.

.4 Strainers installed within steam systems shall be installed with the strainer up, above the pipe.

2.9 STEAM TRAPS

.1 General:

.1 Steam Traps shall meet the steam flow characteristics of the terminal device served with a 2.5X safety factor.

.2 Refer to drawings and schematics for steam trap locations and requirements.

.2 Float and Thermostatic Trap:

.1 Application: continuous flow operation and equipment controlled by modulating temperature control valves. (Examples: unit heaters, air heating coils, heat exchangers.)

.2 Mechanical Failure Mode: Closed

.3 Maximum Allowable Operating Pressure: 861KPa (125 PSI) @ 232 °C (450°F).

.4 Steam traps shall be of the mechanical ball float type having cast iron bodies, NPT connections, and all stainless steel internals. Incorporated into the trap body shall be a stainless steel balanced pressure thermostatic air vent capable of withstanding up to 232 °C (450°F) and resisting water hammer without sustaining damage. Internals of the trap shall be completely serviceable without disturbing the piping.

.3 Inverted Bucket Trap:

.1 Application: Intermittent flow operation, outside air coils or equipment requiring fail proof operation. (Examples: Steam main drip stations.)

.2 Mechanical Failure Mode: Open Maximum Allowable Operating Pressure: 861KPa (125 PSI) @ 232 °C (450°F).

.3 Steam traps shall be of the mechanical inverted bucket type with cast iron bodies, screwed NPT horizontal connections and stainless steel valve head, seat and bucket. Unit shall be complete with an internal bi-metal air vent for rapid air removal on start up. Internals of the trap shall be completely serviceable without disturbing the piping.

.4 Balanced Pressure Bellows Thermostatic Trap:

.1 Application: intermittent flow operation and equipment where cooling of condensate is preferred. (Examples: radiators.)

.2 Mechanical Failure Mode: Closed

.3 Maximum Allowable Operating Pressure: 861KPa (125 PSI) @ 232 °C (450°F).

.4 Steam traps shall be self-adjusting to all pressures within their operating range. Bodies to be of heavy cast iron with NPT connections. Thermostatic elements shall be of precision welded stainless steel construction. All internals to be stainless steel and shall be replaceable without disturbing the piping connections.

2.10 VACUUM BREAKERS

.1 Application: on inlets to steam coils and heat exchangers after control valve to admit air to steam systems where vacuum formation may inhibit system drainage or operation.

.2 Hardened ball check valve design with all working parts manufactured from stainless steel, and shall be suitable for operating conditions of 1378 KPa (200 PSI) saturated steam.

2.11 PILOT OPERATED PRESSURE REDUCING VALVE

.1 Self-operating, external pilot, single seat, diaphragm operated, dead end shutoff, enclosed spring chamber main and pilot valve.

.2 Connections: Under NPS 2 (2"Ø): screwed ends. NPS 2-1/2 (2 ½"Ø) and over: flanged ends.

.3 Main valve body: Ductile cast iron. All internal components will be stainless steel.

.4 Capacity: To meet operational requirements of the system for flow and pressure.

.5 Discharge pressure setting shall be field adjustable.

2.12 STEAM FLOW CONTROL VALVES

.1 Plant steam control valve shall be electric with Multi-Function Technology (MFT), NEMA 2 actuator enclosure rating, 24Vac or 24 Vdc power supply, spring return fail closed. Input signal shall be 2-10 Vdc. Control valve body construction shall be carbon steel with flanged connections with an internal valve trim in high quality 316 stainless steel. Valve shall have a shutoff class IV metal seat with a temperature limit of -320 ºF to 1000 ºF. The control valve shall regulate the steam pressure within the heat exchanger. The control valve shall be CRN registered.

2.13 PRESSURE SAFETY RELIEF VALVES

.1 For low pressure steam service, 860 KPa (125 PSI) ASTM rated, with cast iron body, bronze disc and seat, steel spindle assembly carbon steel spring equipped with lifting service, with capacity based on l0% accumulation at fired vessels.

2.14 DRIP PAN ELBOW

.1 Steel or cast iron with screwed inlet and threaded drain connections.

.2 Threaded outlet with nipple for vent pipe riser.

.3 Nipple to slide freely into vent pipe riser.

.4 Maximum 610 mm (24") distance between relief valve centerline and drip pan elbow discharge centerline.

2.15 FLASH TANK

.1 Tank: vertical horizontal type with threaded drop tube connections. Construction: to ASME code. Maximum working pressure: 860 KPA (125 PSI). Finish: prime coated. Supports: vertical legs for vertical tank.

2.16 PACKAGED CONDENSATE PUMPING UNITS

.1 Heavy Duty Cast Iron Tank, 150 Lit (40 US Gal) Capacity equipped with duplex condensate pumps mounted directly on tank.

.2 Pumps: centrifugal type with two-piece enclosed brass impeller, cast iron housing, high temperature (250ºF) mechanical seal, and stainless steel motor shaft. Each pump shall have a capacity of 40 Gpm at a discharge pressure of 345 KPa (50 PSI), 3 HP, 3600 RPM, 575V/3Ph Motors: Heavy-duty, ballbearing, close-coupled pump motors with stainless steel shaft.

.3 The float switch shall be two-pole with plastic case, stainless steel float and shaft, and double-break silver contacts. A flat perforated brass strainer shall be provided at the inlet to the pump from the tank.

.4 Unit shall be equipped with

- .1 Gauge glass
- .2 Thermometer
- .3 Discharge pressure gauges
- .4 Isolation valves
- .5 Magnetic starters with H-O-A selector switches
- .6 Complete NEMA 12 Control Panel

.5 Controls:

- .1 Duplex automatic: supplied as package by pump manufacturer complete with:
  - .1 Level operated controls.
  - .2 Electrical alternator.
  - .3 High water alarm.
  - .4 Controller in EEMAC 1 enclosure complete with:
    - .1 2 circuit breakers.
    - .2 Through-door operating handles.
    - .3 Two across-line magnetic starters.
    - .4 Ambient compensated quick-trip overloads on each line.
    - .5 Door mounted hand-off-auto selector switches for each pump.
  - .5 Type and quality of electrical components as per Division 26.
- .2 Float switches: quick double break type with silver contacts. Seamless copper float with bronze rod and packed stuffing box.
- .3 Wiring between pumps and controls.

2.17 DRAIN VALVES AND AIR VENTS

.1 Provide drain valves at low points in system piping and manual air vents at high points in system piping. Provide automatic air vents at top of system and at point of controlled air / water separation.

.2 Drain Valves: NPS ¾ (3/4"Ø) ball valves with hose end connection.

.3 Manual Air Vents: NPS ¼ (1/4"Ø) plug valves.

.4 Automatic Air vents: Standard float type ven: brass body and NPS [1/8] connection and rated at 690 KPa (100 PSI) working pressure. Equip automatic air vents with isolation valves to permit servicing without draining the system.

2.18 STEAM METER

.1 Steam meter body shall be constructed of stainless steel.

.2 Units provided with a local digital gauge with kilograms per hour (kg/hr) display with full compensation for temperature and pressure complete with digital 4-20mA output to tie into the University of Guelph building automation system.

.3 Supplier to indicate permanent pressure losses to quantify effect on the installation.

.4 Provide inline meter, complete with proper grounding, display, and warranty.

.5 Meter must be H.A.R.T. compatible.

.6 The sensor to count the vortices shall be capable of withstanding temperatures ranging from - 40º to 500º F.

.7 The sensor shall be constructed of 316 L SS.

.8 Where specified, calibration data shall be supplied which verifies the meter accuracy to be ±1.0 percent of actual flow rate for gases and ±0.75% of flow rate for liquids.

.9 LCD display shall enable the operator to monitor flow rate in clear text messages.

.10 It should be possible to check the functionality and verify deviation of the flow meter without needing to dismantle the device by using an external device. This Verification of transmitter electronics should be traceable to NIST or equivalent standards.

.11 Size meter to meet all present flow rates, as indicated on drawings.

2.19 JLR SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturers to those listed below:

.1	Packaged Condensate Pump Units	Armstrong
.2	Steam Meter	Endress & Hauser Emerson Rosemount Spirax Sarco

PART 3 - EXECUTION

3.1 GENERAL

.1 Comply with piping installation requirements of Section 20 05 05 – Installation of Pipe.

.2 Ream pipes, clean scale and dirt, inside and out, before and after assembly. Cap open ends of piping during installation.

.3 Install flanges or unions at connections to all equipment.

.4 Reducing fittings to be eccentric and installed so as not to trap air.

.5 Provide dielectric couplings for joining dissimilar metals.

.6 Use valves and strainers of same size as pipe to which they are connected, unless otherwise indicated.

.7 Valves to be accessible. Make valves removable without dismantling adjoining pipe.

.8 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.9 Make provision for thermal expansion of piping system and building structure through use of expansion joints, expansion loops and bends and appropriate supports, anchors and guides.

.10 Drip pocket openings to be line size. Drain to traps by gravity.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PIPE SUPPORT

.1 Support and install piping in accordance with Section 20 05 05 – Installation of Pipe.

.2 Provide proper alignment and grade to ensure that the piping system and pipe-supporting elements are protected from excessive stress and distortion from all concurrently acting static and dynamic loads.

.3 Slope low pressure steam piping 40mm in 10 m (½" in 10 ft.) in direction of flow and condensate return piping 60mm in 10 m (3/4" in 10 ft.). Runouts to be reverse sloped. Provide drip trap assembly at all low points and points where condensate may back up upstream of control valves. Run condensate lines from trap, provide vent loop over the trapped section.

.4 Vertical piping: Support or anchor vertical piping at its base and provide a minimum of one intermediate clamp for every other length of pipe except on hot water risers. Clamp every length of pipe with clamps that prevent angular movement on hot water risers where tee fittings are used. Where pipe is installed with fewer or no intermediate clamps supports or anchor the base of the piping and provide sufficient guides to prevent buckling of the pipe.

.5 Provide independent support at equipment connections, concentrated equipment loads (fittings, valves, accessories, etc.), and changes in pipe direction. For grooved joint piping systems support within 600mm (2') either side of joining coupling.

.6 In addition to the pipe supports identified above, refer to the following schedule for minimum hanger spacing for straight length of piping.

Pipe Size	Maximum Support Spacing Sch 40 Steel Piping
NPS ½ (1/2"Ø) - NPS ¾ (3/4"Ø)	2.1 M (7')
NPS 1 (1"Ø) - NPS 1 ½ (1 1/2"Ø)	2.1 M (7')
NPS 2 (2"Ø)	3.0 M (10')
NPS 2 ½ (2 ½"Ø)	3.3 M (11')
NPS 3 (3"Ø)	3.6 M (12')
NPS 4 (4"Ø)	4.2 M (14')
NPS 6 (6"Ø)	4.8 M (16')
NPS 8 (8"Ø)	5.5 M (18')
NPS 10 (10"Ø)	6.7 M (22')
NPS 12 (12"Ø)	6.7 M (22')

3.4 SPECIFIC INSTALLATION REQUIREMENTS

.1 Steam Piping Valve Installation

.1 Install isolation gate valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.2 Install chain operators on valves NPS 4 (4"Ø) and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.

.3 Install flow control globe valves where bypass is required around control valves to control the flow of steam to equipment. Control valves requiring bypass failure control to be equipped with isolation valves on the upstream and downstream side to isolate piping from bypass flow.

.2 Strainers Installation

.1 Install as indicated.

.2 Ensure clearance for removal of basket.

.3 Install valved blow-down as indicated.

.3 Steam Safety Relief Valve Installation

.1 Pipe to atmosphere independent of other vents and in accordance with applicable code.

.2 Support discharge pipe against reaction forces and to take up thermal movement.

.3 Drain pipe from drip pan elbow to discharge to a floor drain.

.4 Packaged Condensate Pumping Units Installation

.1 Place level, shim unit and grout.

.2 Pipe up to system as indicated.

.3 Run tank vent separately to exterior of building in location approved by Consultant.

.4 Run drain line and overflow to terminate over floor drain.

.5 Check rotation prior to start-up.

.6 Check bearings for oil level and lubrication.

.5 Meter Installation

.1 Install as per utility and/or University Metering Standard and instructions and guidelines.

.2 All meter location must be accessible and located in a position that allows ease of maintenance and removal without interfering with the meter accuracy or installation practices.

.3 Meter shall be installed with proper orientation, up and down stream distances and proper grounding as per manufacturer.

.4 Provide all upstream and downstream minimum distances as specified by supplier.

.5 To make good on all surroundings after completion of installation of meter.

.6 Provide insulation by approved sub-contractor to include meter body, surrounding flanges and unions.

.7 Meters, valves, and bypasses should be supported with appropriate adjustable pipe stands. bricks, concrete or wood blocking are not acceptable means of support.

.8 Meter installations must be checked for leakage or contaminants at completion of the installation, the proper operation of the meter should be established.

.9 For meters 2 1/2” diameter and larger provide a mechanical flange adapter on the downstream side of the meter to provide flexibility for meter and strainer case removal.

.10 All flange connections must be supplied with an asbestos-free gasket material top meet temperature and pressure for service.

.11 All documentation and related work shall be provided for the flow rate specified, commissioning, calibration, verification, performance specification and warranty related to the metering device.

3.5 PIPE WELDING

.1 General:

.1 Identify each weld with welder's identification symbol.

.2 Equip welders with fire extinguishers. Observe necessary fire prevention precautions such as shields to minimize fire risk.

.2 Welding

.1 Use only piping with machine bevelled ends for welded runs. Machine bevel pipe and fitting ends. If machining is impractical, prepare ends by grinding, or by flame cutting and subsequent grinding back 3 mm (1/8") prior to welding. Clean each joint internally, swab and remove scale, surface cracks, oil, grease, oxides or other foreign matter.

.2 Make welds full penetration, continuous and without defects. Clean each layer of weld to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer. Weld reinforcement to be not less than 1.6 mm (1/6") and not more than 3 mm (1/8") above normal surface of jointed sections. Crown reinforcement at centre and merge into base material without excessive shoulder on undercut.

.3 Welding Inspection

.1 Make work available at any time for inspection. Cover or insulate welds only after inspection carried out.

.2 The contractor shall engage an experienced firm specialized in radiography to Gamma-ray radiograph and perform these inspections on 5% of welded joints in low pressure hot and cold water systems. Radiograph welded joints over full circumference. The selection of the welds to be inspected shall be done by the Consultant.

.3 Perform radiography in accordance with Article 3 of Section 5 of the ASME Boiler and Pressure Vessel Code and CGSB-48-CP-2. Include all costs in this contract.

.4 Cut out and replace welds of poor or doubtful quality with satisfactory welds.

.5 One or more of the following defects to cause rejection of weld:

.1 Failure to meet radiographic requirements or other code tests.
.2 Welding performed by unqualified personnel.
.3 Welds not reasonably uniform in appearance.
.4 Evidence of peening.
.5 Cracks.
.6 Oxidation around welds.
.7 Lack of fusion.
.8 Presence of porosity, slag inclusion of overlaps.
.9 Undercutting adjacent to completed welds or evidence of undercutting by grinding.

3.6 PIPING SYSTEM TESTING

.1 Piping systems may be tested in whole or partial systems, however all piping systems shall be subjected to testing.

.2 Contractor to complete installation inspection, integrity (pressure, leak) tests and support system inspection before system is insulated, concealed, or covered in any way. Piping not to be covered until all inspection and testing deficiencies have been corrected and successful re-testing has been complete.

.3 Coordinate with authority having jurisdiction the requirement of the authority to witness tests and inspect piping system.

.4 Isolate any equipment not capable of withstanding test pressure. Equipment shall be isolated from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against the test pressure without damage to valve. Blind flanges shall be installed to isolate equipment.

.5 Safety valves shall be set at a pressure no more than one-third higher than the test pressure to protect against damage by expanding liquid or other source of overpressure during test.

.6 Contractor to complete installation inspection, integrity (pressure, leak) tests and support system inspection before system is insulated or enclosed. Piping not to be covered until all inspection and testing deficiencies have been corrected and successful retesting has been completed.

3.7 CLEANING

.1 Not all of the following cleaning procedures are required for any given project. Use the level of cleanliness, type of cleaning procedure and the sequence as specified on the drawings.

.1 FLUSHING

.1 Following completion of hydrostatic testing, drain the test fluid at a rate of flow sufficient to flush any debris or foreign materials from the system.

.2 BLOWING OUT

.1 Vent the steam system to atmosphere, in a safe location, by blowing steam at line pressure through the system and venting, either horizontally or vertically downwards, through full line sized vents, until it is visually evident that discharge of foreign particles has stopped.

.3 WIRE BRUSHING

.1 Prior to blowing out, clean the line by drawing through a wire brush, sized to the full diameter of the line, until no particles remain.

.4 ACID CLEANING

.1 Mix cleaning solutions on site or deliver premixed. Ensure acid cleaning is done by an approved cleaning contractor. Prior to blowing out, degrease and descale the system as follows:

.1 Caustic Flush:

.1 Make up the caustic solution in the following proportions:

.2 For every 1,000 gallons of water - 125 gallons of liquid caustic or 840 pounds of flake caustic, and 400 pounds of Trisodium Phosphate.

.3 When the auxiliary tank is filled with water, add the caustic in the proportions specified, making sure that all solids are dissolved. Trisodium Phosphate has limited solubility in cold water, therefore, in cold weather or in systems with many small bore pipelines, it is advantageous to reduce the amount of this chemical by half. This greatly reduces the amount of Trisodium Phosphate that precipitates and prevents "freeze-ups" in the lines.

.4 Heat the caustic solution until a temperature of about 140 F is obtained. Start circulation.

.5 Maintaining the temperature of 140 F, circulate for a minimum of 4 hours.

.6 Check lines for proper circulation by checking the temperatures.

.7 Treat leaks with caution and do not attempt to correct any during circulation.

.8 Check high points in the piping during the caustic flush to ensure the system remains full of solution.

.9 Water Flush:

.1 Use water to flush the solution in the system back into the pickling tank for disposal.

.2 Continue to flush the system with water allowing the discharge to collect in a holding tank. Flush for one half to one full hour or until discharge is neutral.

.2 Acid flush:

.1 Make up the acid solution in the following proportions:

.2 For every 1,000 gallons of water - 100 gallons 66 Be Sulphuric acid, 5 gallons of inhibitor such as Houghton "ACITROL", and water soluble foam suppressant as required. Heat the acid solution with live steam till a temperature of 140 F is obtained.

.3 Circulate the hot acid solution through lines for a minimum of 4 hours and maintain solution temperature at 140 F.

.4 Check lines for proper circulation by checking the temperatures.

.5 Treat leaks with caution and do not attempt to correct any during circulation.

.6 Check high points in the piping during the acid flush to ensure that the system remains full of solution.

.7 Immerse a heavily scaled or rusted piece of metal in the pickling tank and use this as a measure of the descaling rate of the solution.

.8 Water Flush

.1 Use water to flush the solution in the system back into the pickling tank and then pump out for disposal.

.2 Continue to flush the system with water allowing the discharge to collect in a holding tank. Flush for one half to one full hour or until discharge is neutral. Test with litmus paper.

.3 Keep lines full of water to prevent air from contacting the cleaned surfaces until the system is blown out.

.2 Ensure cleaning takes place immediately prior to line being placed in service so that no corrosion is allowed to take place during this interval.

.3 All cleaning fluids must be neutralized prior to disposal.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section will define the duct construction standards to be utilized.

1.2 REFERENCES

.1 Unless dated references are identified below, it shall be the latest standard issued by the regulatory agency that shall be utilized as the applicable reference.

.2 Sheet Metal Air Conditioning Contractors' National Association (SMACNA):
- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .2 SMACNA HVAC Air Duct Leakage Test Manual.
- .3 SMACNA IAQ Guideline for Occupied Buildings under Construction.

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.4 American Society for Testing and Materials (ASTM):
- .1 ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process. (Metric).
- .2 ASTM A 635/A 635M - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
- .3 ASTM A 480/A 480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .4 ASTM C 423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- .5 ASTM C 916, Standard Specification for Adhesives for Duct Thermal Insulation.
- .6 ASTM C 1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .7 ASTM C 1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
- .8 ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.5 National Fire Protection Association (NFPA):
- .1 NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- .2 NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

.6 Underwriters' Laboratories Inc. (UL):
- .1 UL181, Standard for Factory-Made Air Ducts and Air Connectors.

.7 Underwriters' Laboratories of Canada (ULC):
- .1 CAN/ULC-S110, Fire Tests for Air Ducts.
- .2 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

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

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
.1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
.3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
.4 Product data shall include all relevant information to confirm the specifications have been met.
.5 Product data shall include information as specified in Section 20 01 01 - Common Work Results for Mechanical unless modified with additional information required below.
.6 Additional information required.

.3 Shop Drawings:
.1 Submit duct layout and interference drawings to Consultant for review prior to fabrication. Indicate all duct dimensions, grilles, diffusers, access doors and other pertinent items.
.2 Submit duct construction details; including longitudinal seams, lateral joints, connections, hanger and support system, sealants.

.4 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

.5 Refer to Section 20 05 48 - Vibration and Seismic Controls For Piping, Ducts and Equipment. When the piping and equipment support system is required to be seismically engineered, all product information and shop drawings related to this section shall be submitted as per the requirements of Section 20 05 48. Submit drawings stamped and signed by professional engineer licensed in Province of Ontario, Canada.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor shall verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 The contractor shall supply the following materials to site just prior to substantial being awarded.
.1 Provide one replacement filter for each installed filter.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Contractor performing the work of this section shall be a recognized fabricator and installer of ductwork systems.

.3 Air moving equipment shall bear an AMCA label.

.4 Where applicable equipment shall bear a ULC or UL label.

.5 Provide and construct mock-ups in accordance with Section 01 45 01 - Quality.

.6 Indoor Air Quality (IAQ) Management Plan:

.1 Develop and implement an Indoor Air Quality (IAQ) Management Plan for new construction for construction and preoccupancy phases of building. For occupied buildings, during construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

.7 Supports, anchors and restraints to conform to and be coordinated with the structural requirements of the Ontario Building Code and the requirements of the Structural Engineer responsible for the design of structural support systems for mechanical systems and equipment.

1.6 DUCT PRESSURE CLASIFICATION

.1 Shop fabricated ductwork shall be constructed to meet SMACNA Duct Construction Standards, Latest edition.

.2 Construct all ductwork and fittings to SMACNA Standards for pressures from - 750 Pa to 2500 Pa (-3" w.g. to +10" w.g.) and velocities up to 1220.0 Mpm (4000 Fpm) and / or in accordance with manufacturer's instructions for the specific duct pressure, to the following requirements unless detailed otherwise.

.3 Pressure classification to include for fan shut off with fire damper or other damper closure.

.4 Ducts to withstand 1½ times the lowest possible pressure (fan shutoff pressure) in ductwork which can be isolated by dampers or valves.

.5 Each duct system shall be constructed for the specific duct pressure classifications shown in table below or on the contract drawings.

.6 Where no pressure classes are specified below, the complete system shall be constructed to a 500 Pa (2” wog) pressure classification, regardless of velocity in the duct. Except when the duct is variable volume: all variable volume duct downstream of VAV boxes, the ductwork shall be constructed to a 250 Pa (1” wog) pressure classification.

1.7 DUCT PRESSURE CLASSIFICATION AND SEAL REQUIREMENTS

	Design Operating Pressure	Minimum Design Test Pressure	Maximum Velocity	Design SMACNA Seal Class
ALL Systems				
Fan Discharge or Suction to the first Fire Damper / Shut Off Damper that experienced the full flow without relief / prior branch ductwork.	The Fan Maximum Pressure Capability + 20%	500 Pa (2”SP)	N/A	A
Supply Air Ductwork				
Supply Air Main or Riser	750 Pa (3”wg)	996 Pa (4”wg)	914 Mpm (3000 Fpm)	A
Branch to Terminal Unit	500 Pa (2”wg)	500 Pa (2”wg)	762 Mpm (2500 Fpm)	A
Terminal Unit to Diffuser	125 Pa (0.5”wg)	N/A	610 Mpm (2000 Fpm)	C
Exposed SA Duct within space served	125 Pa (0.5”wg)	N/A	460 Mpm (1500 Fpm)	Not Required
Return Air Ductwork				
Return Air main or Riser	- 500 Pa (-2”SP)	500 Pa (2”SP)	762 Mpm (2500 Fpm)	B
Return Air Branch to diffuser within space served.	- 250 Pa (-1”SP)	500 Pa (2”SP)	460 Mpm (1500 Fpm)	Not Required
Return Air – Discharge of Fan to Supply Fan Suction	500 Pa (2”SP)	N/A	762 Mpm (2500 Fpm)	A
Outside Air Ductwork				
Outside Air Suction to Unit	- 250 Pa (-1”SP)	N/A	610 Mpm (2000 Fpm)	B
Exhaust Air Ductwork				
Exhaust Air Discharge from Return Fan / AHU	250 Pa (1”SP)	N/A	610 Mpm (2000 Fpm)	B
Process Exhaust				
Exhaust Air Main or Riser Positive Pressure from Fan (Examples, Washroom Exhaust Fan Discharge)	500 Pa (2”SP)	500 Pa (2”SP)	762 Mpm (2500 Fpm)	C

1.8 SMACNA SEAL CLASSIFICATION

.1 Duct sealing classifications to be in accordance with SMACNA and the following:

.1 **SMACNA Seal Class A:** seal all transverse joints, longitudinal seams and duct wall penetrations and made airtight with gaskets, grommets, mastics or liquid sealants. Testing of the assembled length of duct only, section must meet or exceed ASHRAE leakage Class 1.5, 1% of airflow at 500 Pa (2" w.g.).

.2 **SMACNA Seal Class B:** seal all transverse joints and longitudinal seams and made airtight with gaskets, mastics or liquid sealants. Testing of the assembled length of duct only, section must meet or exceed ASHRAE leakage Class 3, 2.4% of airflow at 500 Pa (2" w.g.).

.3 **SMACNA Seal Class C:** seal all transverse joints and made airtight with gaskets, mastics or liquid sealants. Testing of the assembled length of duct only, section must meet or exceed (ASHRAE leakage Class 6), 4.7% of airflow at 500 Pa (2" w.g.).

.2 Definitions:

.1 Longitudinal seams are joints oriented in the direction of flow.

.2 Transverse joints are connections of two duct sections oriented perpendicular to airflow. Spiral lock seams in a round or flat oval duct need not be sealed. All other connections are considered transverse joints, including but not limited to spin-ins, taps, and other branch connections, access door frames and jambs, duct connections to equipment, etc.

.3 Duct wall penetrations are openings made by any screw fastener, pipe, rod, or wire.

.3 Duct leakage not to exceed the lesser of 1.0 L/s per m² of duct surface area or 1% of the average airflow in duct or riser at 500 pa 2”.

1.9 DUCT STRUCTURAL REQUIREMENTS AND REINFORCEMENT

.1 Duct material to resist deflection caused by internal pressure and vibration due to turbulent airflow. Internal pressure to include for fan shutoff due to fire damper or other damper closure under normal or emergency conditions.

.2 Maximum deflection of rectangular duct as follows:

.1 Up to 305 mm - 10 mm (Up to 12" - .375");

.2 330 to 459 mm - 13 mm (13" to 18" - .500");

.3 460 to 609 mm - 16 mm (19" to 24" - .625");

.4 610 mm and up - 19 mm (24" and up - .750").

.3 Maximum amplitude of vibration of sheet is 0.4 mm (1/64").

.4 Reinforcing: maximum allowable deflection of reinforcing at operating pressure is 6 mm (0.25").

.5 Seams: longitudinal seams to withstand 1½ hours maximum operating pressure without failure or leakage.

.6 Joints: transverse joints to withstand 1½ times the maximum operating pressure without failure or leakage.

.7 Individual seams and joints to be airtight at 1½ times system operating pressure.

.8 Beam Strength of Duct Section: duct section between adjacent hangers to carry its own weight and resist external loads.

1.10 SMACNA VARIANCES

.1 The use of SMACNA Duct Construction Standards – Metal and Flexible (Latest Edition) shall be utilized except where deviations are noted herein.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Provide ductwork of galvanized steel except where otherwise noted on drawings or specified herein.

.2 Construct round, rectangular, square, and flat oval duct as specified herein.

.3 Duct dimensions shown in the contract drawings are for airflow area. When ducts are acoustically lined, their dimensions shall be increased as necessary.

2.2 DUCT MATERIAL - METAL

.1 Galvanized Steel:
- .1 Standard duct construction material.
- .2 Lock forming quality: to ASTM A 653/A 653M, G90 zinc coating.
- .3 Thickness, Fabrication and Reinforcement: to SMACNA requirements.
- .4 Joints: to SMACNA construction standards.

2.3 DUCT FITTINGS

.1 Fabrication: to SMACNA. Application as follows or as indicated on the drawings.

.2 General:
- .1 Provide volume control damper in branch duct near connection to main duct. Provide extended shafts for ducts with insulation.

.3 Duct Transitions: bull nose size transitions will not be accepted. Duct size transitions shall be minimum 30 degrees maximum included angle on any one face.

.4 Duct fitting for use downstream of VAV boxes, low velocity / pressure applications:
- .1 Elbows:
  - .1 Rectangular / square radiused elbows: short radius square throat, centerline radius: 0.5 times width of duct.
  - .2 Rectangular / square mitered elbows: single thickness turning vanes.
  - .3 Round / oval radiused elbows: four piece adjustable elbow, centreline radius: 1.0 times diameter.
  - .4 Round / oval mitered elbows are not permitted.
- .2 Branches:
  - .1 Rectangular / square main – rectangular / square branch: radius on branch 1.0 times width of duct with splitter damper or, if shown, 45 degrees entry on branch.
  - .2 Rectangular / square – round /oval: with conical connection.
  - .3 Round / oval main – round / oval branch: with conical connection.
  - .4 Branch to diffuser / VAV box: spin in collar tee.
- .3 Duct offsets shall be a combination of 45° radiused elbows with interstitial duct or mitered elbows with turning vanes.

.5 Duct fitting for use upstream of VAV boxes, medium velocity / pressure applications.

.1 Elbows:

.1 Rectangular / square radiused elbows: short radius centerline radius: 1.0 times width of duct. If duct is over 800 mm (32") width, provide single thickness turning vanes at each 300 mm in width or centred.

.2 Rectangular / square mitered elbows: single thickness turning vanes.

.3 Round / oval radiused elbows: five piece elbow, centreline radius: 1.0 times diameter.

.4 Round / oval mitered elbows are not permitted.

.2 Branches:

.1 Rectangular / square main – rectangular / square branch: radius on branch 1.0 times width of duct with splitter damper or, if shown, 45 degrees entry on branch.

.2 Rectangular / square main – round / oval branch: 45°/straight backed rectangular connection and round/oval discharge.

.3 Round / oval main – round / oval branch: conical connection.

.3 Duct offsets shall be a combination of 45° radiused elbows with interstitial duct or mitered elbows with turning vanes.

.6 Duct fitting for use on high velocity systems and systems limiting static pressure loss.

.1 Elbows:

.1 Rectangular / square radiused elbows: standard radius centerline radius: 1.5 times width of duct. If duct is over 590 mm (24") width, provide single thickness turning vanes at each 300 mm in width or centred.

.2 Rectangular / square mitered elbows: To 300 mm (12") width single thickness turning vanes. Over 300 mm (12") width double thickness turning vanes.

.3 Round / oval radiused elbows: smooth radius elbow, centreline radius: 1.5 times diameter.

.4 Round / oval mitered elbows are not permitted.

.2 Branches:

.1 Rectangular / square main – rectangular / square branch: radius on branch 1.5 times width of duct with splitter damper.

.2 Rectangular / square main – round / oval branch: 45°/straight backed rectangular connection and round / oval discharge.

.3 Round / oval main – round / oval branch: conical connection.

2.4 DUCT SUPPORT SYSTEMS AND HANGERS

.1 Duct supports, hanging shall be in accordance with SMACNA HVAC Duct Construction Standards.

.2 Coordinate the location, spacing and sizing or hangers with other services to provide a coordinated installation.

.3 Construction standards and spacing of support systems and hangers for duct distribution systems in accordance with SMACNA HVAC Duct Construction Standards or as modified herein.

.4 Upper attachment to building to be in accordance with SMACNA HVAC Duct Construction Standards. Or as modified herein.

.1 Friction clamps to steel structure will not be acceptable.

.2 Attachments to metal roof deck not permitted.

.3 Attachments to steel structure to be bolted type connections.

.4 Beam attachments to provide concentric support on both sides of beam.

.5 Hangers and Lower Attachment to ductwork to be in accordance with SMACNA HVAC Duct Construction Standards. Or as modified herein.

.1 Wire hangers will not be acceptable.

.2 Band / Strap Hangers: of same material as duct and use shall be limited to ductwork which does not exceed 600 mm (24”) width or 600 mm (24”) diameter.

.3 Trapeze Hangers: ducts over 600 mm diameter or longest side, to SMACNA.

.4 Hangers: black steel angle with black steel rods to SMACNA.

2.5 SEISMIC REQUIREMENTS

.1 Refer to 20 05 48 - Vibration and Seismic Controls For Piping, Ducts and Equipment for seismic requirements for this project.

2.6 SEALANTS AND TAPES

.1 General:

.1 All duct sealing products shall be UL181A-M and UL181B-M listed.

.2 All duct sealing products shall be tested in accordance with ULC S102, flame spread not to exceed 25, smoke developed not to exceed 50.

.3 Products will meet all SMACNA pressure classes up to 10" w.g. and SMACNA seal Classes A, B, and C on ducts constructed to SMACNA standards.

.4 Exterior applied products shall be UV resistant.

.5 Product stability shall be maintained thru a minimum of 5 freeze / thaw cycles.

.2 Duct Sealant (Mastic):

.1 Description: water based synthetic polymer, oil resistant, flame resistant, fungal resistant duct sealant.

.2 Application: painted on with a brush, trowel applied, or applied with a caulking gun.

.3 Application Temperature: 4.4°C to 38°C (40°F to 110°F).

.3 Joint Gaskets:

.1 Neoprene gasket tape, self-adhesive closed cell, neoprene blend elastomeric foam.

.4 Cloth backed – Rubber adhesive Tape:

.1 Tapes to be used only in conjunction with a sealant on flat surfaces. Do not apply tape to bare metal or dry sealant.

.2 Polyvinyl treated, open weave fiberglass tape, 50 mm (2”) wide.

2.7 FLEXIBLE DUCTWORK

.1 General:

.1 All flexible ductwork products shall meet UL Standard 181 as a Class 1 flexible air duct.

.2 All products shall have flame spread and smoke development ratings in accordance with CAN/ULC S102-M88:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

.3 Flexible ductwork shall comply with NFPA 90A and 90B.

.4 Flexible ductwork shall not be installed in exposed applications.

.2 Insulated Acoustic Flexible Ductwork (Metal):

.1 Application: supply air connections to diffusers.

.2 Spiral wound, mechanically bonded, flexible perforated (25%) aluminum inner core. Wrapped with 25 mm (1") thick flexible mineral fiber thermal insulation and factory jacketed with spiral wound aluminum vapor barrier.

.3 Maximum Bend Radius: 2.5 x inside diameter.

.4 Acoustical Performance:

Acoustic Flexible Duct Attenuation Performance (Db / Metre) @ Frequency (Hz) Indicated				
250	500	1K	2K	4K
8	13	23	23	20

.3 Flexible Ductwork (Metal):

.1 Application: Un-insulated Supply and Return Air connections to diffusers.

.2 Spiral wound, mechanically bonded, flexible aluminum.

.3 Maximum Bend Radius: 2.5 x inside diameter.

.4 Insulated Acoustic Flexible Ductwork (Fabric):

.1 Application: Supply Air connections to diffusers.

.2 Nylon fabric attached to aluminum helix inner core. Wrapped with 25 mm (1") thick flexible mineral fibre thermal insulation and factory jacketed with scrim foil mylar vapor barrier.

.3 Maximum Bend Radius: 0.5 x inside diameter.

2.8 FLEXIBLE CONNECTIONS

.1 Neoprene coated glass fabric, coated both sides, minimum mass 1.32 kg/m² (39 oz/yd²), secured to ducts and fans with 38 mm x 3 mm (1½" x 1/8") galvanized steel flat bars using galvanized steel screws at 100 mm (4") intervals.

.2 Flexible connections will not be more than 150 mm (6") long between metal parts and with sufficient slack to prevent vibration transmission and allow for movement of equipment.

2.9 ACCOUSTIC INSULATION

.1 General: Long textile type fibre, Mineral fibre, acoustic rigid duct liner: air surface coated mat polymer spray applied facing. 25 mm (1") thick, to ASTM C 1071, fibrous glass rigid board duct liner.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.

.3 Recycled Content: minimum 35% by weight recycled content. Binder shall contain no phenol, formaldehyde or acrylics.

.4 Fungi Resistance: to ASTM C 1338.

.5 Maximum velocity on faced air side: 1220 Mpm (4000 Fpm).

.6 Acoustical performance:

Acoustic Rigid Duct Liner Attenuation Performance (Db / Metre) @ Frequency (Hz) Indicated. 25 mm (1") Thick Board						
P/A	125	250	500	1K	2K	4K
6	1.6 (0.5)	3.9 (1.2)	7.5 (2.3)	16.4 (5.0)	19.0 (5.8)	11.8 (3.6)
4	1.3 (0.4)	2.6 (0.8)	6.2 (1.9)	13.1 (4.0)	13.5 (4.1)	9.2 (2.8)
1	0.4 (0.1)	1.0 (0.3)	3.8 (1.0)	6.6 (2.0)	3.9 (1.2)	3.9 (1.2)
P/A = duct perimeter (ft) / duct cross sectional area (ft2)						

.7 Fasteners:

.1 Adhesive: Water-based fire retardant type adhesive: to ASTM C 916. Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50.

.2 Weld pins, length to suit thickness of insulation. Metal retaining clips, 32 mm (1 ¼ ") round / square.

.8 Unless otherwise noted, ALL duct dimensions on the plans / drawings shall be Net, Inside Dimensions. The installing contractor shall construct the sheet metal ductwork with additional width and height to accommodate the internal acoustic insulation as required and identified.

2.10 DISSAPATIVE SILENCERS

.1 Factory manufactured Square / Rectangular / Round and Straight / Elbowed dissipative sound power reducing sheet metal perforated silencers. With bell-mouth entrance and exponential exit.

.2 All silencers shall be tested in accordance with the ASTM E- 477 silencer test code.

.3 Construct silencers of minimum 0.8 mm (22 Ga) galvanized steel shells. Provide with unobstructed internal air passages to ensure uniform performance. Internal panels to be 0.8 mm (22 Ga) galvanized and perforated steel, die-stamped in one piece,

.4 Acoustic medium to be minimum 75 kg/m (4.5 lb/ft.) density glass fibre. Furnish standard modules. Where two or more standard modules are required to compose a silencer, provide galvanized nosing pieces to cover adjacent silencer shell edges.

.5 Refer to drawings for required dimensions and insertion losses.

2.11 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire stopping.

.2 Fire stopping material and installation must not distort duct.

2.12 AIR HANDLING UNIT CASINGS AND PLENUMS CONSTRUCTION

.1 Floor mounted air handling unit casings and outside air intake / exhaust plenums shall be constructed in accordance with SMACNA double wall casing construction details and as indicated below.

.2 Make all fresh air intake ducts watertight. Slope to exterior wall and fit with suitable drain connection at bottom. Coat inside of ductwork on bottom and up sides with waterproof mastic.

.3 Construct apparatus, sheet metal connections, plenum chambers and casings of 1.2 mm (18 Ga) galvanized metal.

.4 Fabricate casings and connections to avoid restrictions in air flow. Where changes in shape or cross-sectional area are necessary, slope for airstream to be limited to 45° angle in direction of airflow.

.5 Form all joints in casings with 38 mm (1½") high standing seams. Reinforce all seams with 38 mm x 38 mm x 4.8 mm (1½" x 1½" x 3/16") steel angles. Place seams perpendicular to airflow and outside of casings on not greater than 900 mm (36") centres. Place supplemental reinforcing angles inside casing, parallel to air flow on 900 mm (36") centres, where span of casing equals or exceeds 2100mm (84").

.6 Construct access doors and frames of 1.2 mm (18 Ga) galvanized steel of double panel construction with 25 mm (2”) rigid insulation between metal panels. Walk-through type access doors to have minimum of two handles for tight closure against continuous neoprene gasket formed into frame and arranged for operation from either side of door. Mount all doors on doorframe with three steel butt hinges. Frame door and brace to nearest bracing angles with galvanized reinforcing angles.

.7 At floor line and at other points where casings join masonry construction, rivet casing on maximum 300 mm (12") centres to 38 mm x 38 mm x 3.2 mm (1½" x 1½" x 1/8") angle. Secure angles to masonry with expansion or toggle bolts on 300 mm (12") centres and caulk airtight to masonry.

2.13 ACCESS DOORS AND TEST PORTS

.1 Provide for access to fire or other dampers, for service or inspection and for cleaning of turning vanes and ductwork.

.2 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 1.0 mm (20 Ga) thick complete with sheet metal angle frame.

.3 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 1.0 mm (20 Ga) thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.4 Gaskets: neoprene.

.5 Hardware:

- .1 Up to 300 x 300 mm (12”x12”): two sash locks.
- .2 301 to 450 mm (12” – 18”): four sash locks.
- .3 451 to 900 mm (18” – 36”): piano hinge and minimum two sash locks.
- .4 Doors over 900 mm (36”): piano hinge and two handles operable from both sides with hold open devices and 250 x 250 mm (10”x10”) glass viewing panel.

.6 Access doors to be sized for application and access requirement. Contractor to verify and demonstrate that the access door provides required space for purpose of installation.

.7 Duct test ports shall be 28 mm minimum inside diameter. Length to suit insulation thickness. Cam lock handles, with neoprene expansion plug and handle chain. Neoprene mounting gasket.

2.14 WATERTIGHT DUCTWORK

.1 Provide watertight duct for:
- .1 Dishwasher exhaust.
- .2 Fresh air intake.
- .3 Minimum 300 mm (12”) upstream and 600 mm (24”) downstream from duct mounted humidifier discharge manifold.
- .4 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams. Weld joints of bottom and side sheets. Seal other joints with duct sealer. Slope horizontal branch / connecting ductwork down towards sealed section of duct.

.3 Fit base of riser / plenum / manifold section, with 150 mm (6”) deep drain sump and 25 mm (1”Ø) drain connected, with deep seal trap and ball valve, discharging to open funnel drain or as indicated.

2.15 JLR SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements of alternate manufacturer’s to those listed below:

.1	Sealants and Tapes	Duro-Dyne
.2	Flexible Ductwork	Flexmaster
.3	Flexible Connections	Duro-Dyne
.4	Acoustic Insulation	Johns Manville
.5	Silencers	Vibro Acoustics
.6	Fire stopping	3M
.7	Access Doors	Duro-Dyne

PART 3 - EXECUTION

3.1 GENERAL

.1 Ductwork shall be fabricated / manufactured and installed to meet or exceed the pressure classifications and seal classification, as specified herein.

.2 Ductwork shall be fabricated / manufactured and installed as indicated on the drawings. Minor variations to location, reduced sizes for short lengths, modified sizes maintaining original area, fitting style, and round vs rectangular may be acceptable to accommodate for site conditions, structural requirements, and space limitations. These revisions should be coordinated with the other trades utilizing / installing within the same space. These revisions to the design of the system should be reviewed with and coordinated with the Consultant.

.3 Do not break continuity of insulation vapor barrier with hangers or rods. In the case of strap hangers Insulate strap hangers 100 mm (4”) beyond insulated duct.

.4 Install ductwork and accessories to provide a system free from buckling, warping, breathing or vibration.

.5 Provide dielectric isolation or other method to prevent corrosion due to contact with uncoated steel or copper.

.6 No pipes, wire, structural member or other obstruction will be allowed in ductwork or to penetrate ductwork unless reviewed with and coordinated with the Consultant.

.7 Duct routing, connections and take-offs to follow building lines.

.8 Coordinate duct and supporting elements with building architectural, structural, and electrical systems to ensure proper installation and access for maintenance and service.

.9 Coordinate duct supporting elements with other mechanical systems.

.10 Do not conceal duct installation before the completion of the Contractor's quality assurance inspection and testing and approval of local authorities having jurisdiction.

.11 Protect openings against entry of foreign material.

.12 Install ductwork to minimize furring space, maximize headroom, and conserve space.

.13 Install ducts to permit separate thermal insulation of each duct.

3.2 MANUFACTURER’S INSTRUCTIONS

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

3.3 DUCT SUPPORT

.1 The design of duct supporting elements is dependent on Contractor controlled methods of installation and the physical characteristics, limitations and operating characteristics of the duct distribution system.

.2 Contractor controlled methods of installation include the physical location of the duct (distance to support structure), method of support (hanger, trapeze, etc.), attachment location (roof structure, column, interior wall, etc.), attachment method (cast in place, expansion inserts, structural bridging, clamping, etc.) and distribution systems being supported (single, multiple, etc.).

.3 Coordinate support system design with the requirements and constraints of the connected equipment, structure, vibration isolation systems and seismic restraint systems.

.4 Support risers in accordance with SMACNA.

3.4 CONNECTIONS TO BUILDING STRUCTURE

.1 Spacing, location and loading of individual attachments and all duct support attachments not to exceed capacity of structure.

.2 Attachments to concrete floor to be at least 400 mm from edge of slab.

.3 Attachments to concrete floor to be cast in place inserts or expansion studs and anchors. Explosive actuated fasteners not permitted.

.4 Attachments to composite metal roof deck not to interfere with composite behaviour of roof deck structure.

.5 Attachments to metal roof deck not permitted.

.6 Locate connections to open web steel joists at panel points.

.7 Attachments to steel structure to be bolted type connections.

.8 Beam attachments to provide concentric support on both sides of beam.

.9 Maximum loads on attachments to concrete not to exceed one-fifth of the ultimate strength of the attachment as determined by manufacturer's tests. Install attachments in accordance with manufacturer's requirements.

3.5 FIRE STOPPING

.1 All fire stopping shall be the work of one contractor. Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation Division 07 Standards.

.2 Provide fire / smoke dampers where indicated and as specified.

.3 Install breakaway joints in ductwork on sides of fire separation.

3.6 ESCUTCHEONS

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

.2 Sizes: outside diameter to cover opening or sleeve. Inside diameter to fit around duct or outside of insulation if so provided.

3.7 CONNECTIONS TO EQUIPMENT

.1 Duct support shall be independently supported from equipment. Weight of piping shall not be imposed upon connections to equipment.

.2 In accordance with manufacturer's instructions unless otherwise indicated.

.3 Use flanges for isolation and ease of maintenance and assembly.

3.8 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, and components.

3.9 SEALANT INSTALLATION

.1 Ensure all surfaces where sealant or tape is to be applied have been thoroughly cleaned with soap and water and dried. Surfaces should be free from oils, grease, dust, dirt, rust, moisture, ice crystals, and other substances that inhibit or prevent bonding and contaminations.

.2 Temperatures should be within application temperature range.

.3 Tapes to be used only in conjunction with a sealant on flat surfaces. Do not apply tape to bare metal or dry sealant. Ensure tape adhesive backing is compatible with sealant to ensure bonding.

3.10 FLEXIBLE DUCTWORK INSTALLATION

.1 Connect flexible ducts to other ductwork or equipment with stainless steel gear clamps. Secure joints by minimum three wraps of pressure sensitive, vapor seal adhesive tape or with mastic duct sealant and sheet metal screws.

.2 Length of flexible ductwork not to exceed 2.0 m (6.5 ft.). Flexible ductwork shall be run minimizing the bends and 90°elbows and limiting the length of flexible duct to that which is required only. Flexible duct sections shall be continuous with no intermediate joints.

.3 Support flexible ducts by hangers every 1.2 m (4 ft.) unless supported adequately by ceiling construction. Support method to prevent duct damage by vibration or other motion. Do not lay ducts across light fixtures or other hot surfaces.

.4 Flexible ductwork shall not pass through floors of fire walls.

.5 Flexible ductwork shall be a single section of duct (no joints).

.6 Flexible ductwork shall be connected to sheet metal duct and diffusers using duct sealer, minimum of 2 screws (180° apart), and metal draw bands.

3.11 FLEXIBLE CONNECTION INSTALLATION

.1 Install flexible connections to isolate vibration and provide adequate system performance. Provide for air moving equipment at the following locations:

.1 Fans: inlet and discharge.

.2 Air handling units: inlet and discharge.

.2 Install flexible braided copper wire jumper (No. 2/0 copper or heavier) across each flexible connection, fastened to ductwork and unit. Secure lugs with sheet metal screws.

.3 Install flexible connections not more than 150 mm (6") long between metal parts and with just sufficient slack to prevent vibration transmission. Allow movement of 50 mm (2").

.4 Flexible connections shall be adjusted such that the material DOES NOT restrict the airflow entering or exiting fans.

3.12 INTERIOR ACOUSTIC INSULATION / DUCT LINER

.1 Acoustically line ductwork where indicated or noted.

.2 Secure insulation to duct with fire resistant adhesive, welded pins and clips on 400 mm (16") centres.

.3 Caulk interior butt joints and edges of insulation with fire resistant mastic.

.4 Metal nosing shall be used on leading edges of each piece of lined duct when the velocity exceeds 4000 Fpm (20.3 mls) otherwise, it shall be used on the leading edge of any lined duct section that is preceded by unlined duct.

3.13 ACCESS DOOR INSTALLATION

.1 Install access doors at all devices requiring service, adjustment and cleaning, including the following:
- .1 Fire dampers.
- .2 Control dampers.
- .3 Drain pans.
- .4 Humidifier duct grids.
- .5 Duct mounted coils and filters.

.2 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fiberglass tape and water based duct sealer. Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.

3.14 TESTING

.1 In accordance with SMACNA HVAC Duct Leakage Test Manual and as indicated below. Complete test before performance insulation or concealment

.2 Do leakage tests in sections. Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows. Make trial leakage tests as instructed to demonstrate workmanship. Do not install additional ductwork until trial test has been passed

.3 Test high pressure risers and mains by means of a small pressure blower, with calibrated meter and U-gauge manometer to measure the test static pressure developed in the ductwork.

.4 Carry out leak tests at test pressure 500 Pa (2" w.g.) above system design pressure and repeat until leakage is proven at less than the following:

.1 Seal Class A: 1% of airflow;

.2 Seal Class B: 2% of airflow;

.3 Seal Class C: to testing required.

.5 Carry out duct structural test at test pressure 1.5 times the maximum pressure possible (fan shutoff pressure) in ductwork that can be isolated by dampers or valves under normal or emergency conditions.

.6 Test VAV systems at design pressure that could exist at minimum as well as maximum flow conditions.

3.15 DUCT CLEANING

.1 Following the complete installation of new systems, vacuum clean interior of all ductwork to insure the removal of all dust, contaminants and trash from the duct distribution system.

.2 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through other zones that have already been cleaned.

.3 Install access doors and panels for equipment where required to facilitate system inspection and cleaning. Remove and reinstall ceilings to gain access to HVAC system as required.

.4 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.

.5 Pass brushes through sections as often as necessary to achieve required cleanliness.

.6 Change brush sizes as required to ensure positive contact with duct and component interiors.

.7 Clean corners and pockets where dirt and debris can accumulate.

.8 Clean equipment, components and other features in isolated zone before moving to next zone of HVAC air duct system.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section defines the accessories required for the installation of a ductwork distribution system.

1.2 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

.2 Sheet Metal Air Conditioning Contractors' National Association (SMACNA):
- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .2 SMACNA HVAC Air Duct Leakage Test Manual.
- .3 SMACNA IAQ Guideline for Occupied Buildings under Construction.

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.4 National Fire Protection Association (NFPA):
- .1 NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- .2 NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.5 Underwriters' Laboratories Inc. (UL):
- .1 UL181, Standard for Factory-Made Air Ducts and Air Connectors.

.6 Underwriters' Laboratories of Canada (ULC):
- .1 CAN/ULC-S110, Fire Tests for Air Ducts.
- .2 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .3 CAN4-S112, Fire Test of Fire Damper Assemblies.
- .4 CAN4-S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
- .5 ULC-S505, Fusible Links for Fire Protection Service.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data will include all relevant information to confirm the specifications have been met.
- .5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, that are operating at their upper and lower limits for their design duty performance.

.6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data will include any relevant information that Division 25 requires for a properly functioning building automation system.

.8 Product data will include information as specified in Section 20 01 01 – Common Work Results for Mechanical unless modified with additional information required below.

.9 Additional information required.

1.4 MAINTENANCE REQUIREMENTS

.1 The contractor will verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 The contractor will supply the following materials to site just prior to substantial being awarded:

.1 Ten (10) fusible links of each type of fire damper.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Contractor performing the work of this section will be a recognized installer of ductwork distribution systems that can be documented and verified.

.3 Electrical equipment will bear a CSA label or have an ESA certification.

.4 Air moving equipment will bear an AMCA label.

.5 Where applicable equipment will bear a ULC or UL label.

.6 Once the installation (including ceilings) has been completed, the Contractor will verify that the fusible links for all fire dampers can be replaced.

.7 Provide and construct mock-ups in accordance with Section 01 45 01 – Quality.

PART 2 - PRODUCTS

2.1 GENERAL

.1 The Installation will conform to SMACNA HVAC Duct Construction Standards, Metal and Flexible.

.2 All dampers will be constructed from the same material as the ductwork in which it is installed.

.3 Contractor will coordinate the installation of balancing dampers with the TAB (Testing and Balancing) Contractor to ensure that the system can be balanced as per the performance requirements. TAB contractor to provide guidance and advice on the location and type of balancing damper to be employed.

.4 Contractor will coordinate the installation of control dampers with Division 25, Controls Contractor to ensure that the system can be controlled as per the performance requirements. Controls / EMCS contractor to provide guidance and advice on the location and type of dampers to be employed.

.5 It is recommended that the contractor mock-up the installation of a fire damper for review with the authority having jurisdiction.

2.2 FIRE DAMPERS

.1 Fire dampers will be curtain type, Type B (stacked blades outside the air stream) unless otherwise identified or approved:

- .1 Type A fire dampers (stacked blades restricting airflow, within the air stream) will not be utilized unless approved by the Consultant.
- .2 Type C fire dampers (stacked blades providing 100% free area), will be utilized for duct distribution systems where the Design Operating Pressure is 100 Pa (4”wog) or greater.

.2 Fire Dampers will be ULC listed and bear a ULC label. Fire dampers will also meet the requirements, once installed, of the local authority having jurisdiction. Fire damper assemblies will have been fire tested in accordance with CAN4-S112.

.3 Fire damper will be Dynamic Type.

.4 Fire dampers will be suitable for maximum air velocity and pressure differential to which it will be subjected.

.5 Fire dampers will be activated with a fusible link, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow. Fusible Links will be rated for 74°C (165°F), unless otherwise indicated.

.6 Construction:

- .1 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .2 Top Hinged: round or square, multi-blade hinged, sized to maintain full duct cross sectional area.
- .3 Equip fire dampers with steel sleeve or frame.
- .4 45 x 45 x 3 mm (1 ½ x 1 ½ x 1/8”) retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .5 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform to ULC.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

.1 Combination Fire / Smoke Dampers: to be ULC or UL listed and labelled.

.2 Motorized (S/D-M): folding blade type, normally open with power on. When power is interrupted damper will close automatically. Both damper and damper operator will be ULC listed and labelled.

.3 Electro Thermal Link (S/D-ETL): dual responsive fusible link that melts when subjected to local heat of 74°C (165°F) and from external electrical impulse of low power and short duration; ULC or UL listed and labelled.

.4 Combined Actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.

.5 120V / 1Ph power supply from Division 26.

2.4 OPERATING / CONTROLLED DAMPERS

.1 Disc Type Control Dampers:

.1 Frame: brake formed, welded, 1.6 mm (16 Ga) thick, galvanized steel to ASTM A 653/A 653M.

.2 Disc: spin formed, 1.6 mm (16 Ga) thick, galvanized steel to ASTM A 653/A 653M.

.3 Gasket: extruded neoprene, field replaceable.

.4 Bearings: roller self-lubricated and sealed.

.5 Performance: leakage in closed position, less than 1 % of rated airflow at 500 Pa (2”wg) pressure differential across damper.

.2 Multi Leaf Control Dampers:

.1 Opposed blade type for applications requiring air volume control.

.2 Parallel blade dampers will be utilized for two position (Open / Closed) control requirements.

.3 Where two dampers are required for mixing control, such as an outside air / return air mixing chamber, outside air will be opposed blade and the return air will be parallel blade.

.4 Dampers will be constructed from the same material as the ductwork in which it is installed, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded frame. Pressure fit self-lubricated bronze bearings.

.5 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

.6 Performance: leakage: in closed position less than 2% of rated air flow at 500 Pa differential across damper.

.3 Multi Leaf Control Dampers (Insulated):

.1 For use on outside air intake control dampers and exhaust isolation dampers and discharge point.

.2 Same specification as that indicated above with the following exceptions:

.1 Construction material will be aluminum.

.2 Frames: insulated with extruded polystyrene foam with RSI 0.88. Frames will be thermally broken.

.3 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

.4 Control Damper Operators:

.1 Damper operator will be provided and installed by Division 25, if specifications for Division 25 are provided, otherwise.

.2 Electronic Damper Operators for Variable Position Control:

.1 Direct mount proportional type with spring return for "fail-safe" in Normally Open or Normally Closed position, as indicated.

.2 Microprocessor-controlled brushless DC motor operator.

.3 Operator torque, sized to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

.4 Actuator will be equipped with a built-in mechanical stop to adjust angle of rotation, and have the damper position viewed easily with clear position indicator.

.5 Built-in auxiliary switches providing feedback or signal for additional device.

.6 Field adjustable rotation direction.
.7 Housing: aluminum dye cast and plastic casing, NEMA 2 Enclosure Type 2.
.8 Power Requirements: 24 V AC.
.9 Operating Range: 0 - 10 V DC or 4 - 20 mA DC.
.10 Damper actuator to drive damper from full open to fully closed will be field adjustable and variable from 60 – 150 seconds.

.3 Electric Damper Operators for Open / Closed Position Control:
.1 Direct mount proportional type with spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
.2 Operator Torque: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
.3 Actuator will be equipped with a built-in mechanical stop to adjust angle of rotation, and have the damper position viewed easily with clear position indicator.
.4 Built-in auxiliary switches providing feedback or signal for additional device.
.5 Field adjustable rotation direction.
.6 Housing: aluminum dye cast and plastic casing, NEMA 2 Enclosure Type 2.
.7 Power Requirements: 120 V AC.
.8 Damper actuator to drive damper from full open to full closed in less than 80 seconds.

.4 Control Power Transformers:
.1 Control transformers will be 120V - 24V, 60 Hertz transformers, installed to meet the power requirements of the connected devices with an additional 25% spare capacity.
.2 Transformers will be ULC listed and CSA certified.
.3 Standard design will be single phase, all welded core construction made with high quality, high permeability silicon steel laminations. Coils will be accurately wound with high quality magnetic wire with insulation film. All units from 50VA to 5kVA are encapsulated with electrical grade silica sand and resin compounds. Transformers will be complete with heavy duty NEMA 3 Conduit knockouts on sides and rear of enclosure. Front accessible wiring compartment with high and low voltage copper lead wires or tabs. Ample space for transformer connection for primary and secondary terminations.
.4 Insulation: up to 1kVA; Class B, 80°C temperature rise. 1.5 to 5kVA; Class F, 115°C temperature rise.
.5 Mounting: designed for vertical or horizontal mounting.

2.5 BALANCING DAMPERS

.1 Splitter Dampers:
.1 Construction in accordance with SMACNA guidelines. For use as a rough balancing tool only.
.2 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
.3 Control rod with locking device and position indicator with shaft extension to accommodate insulation thickness.
.4 Extended Pivot: piano hinge.
.5 Folded leading edge.

.2 Single Blade Balancing Damper:
.1 Construction in accordance with SMACNA guidelines.
.2 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
.3 Size and configuration to recommendations of SMACNA, except maximum height of the single blade for rectangular duct will be 200 mm (8”).
.4 Locking quadrant with shaft extension to accommodate insulation thickness.

.5 Inside and outside nylon end bearings.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

.3 Multi Blade Balancing Damper:

.1 Factory manufactured of material compatible with duct.

.2 Opposed Blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum Blade Height: 100 mm (4”).

.4 Bearings: self-lubricating nylon.

.5 Linkage: locking quadrant with shaft extension to accommodate insulation thickness.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

2.6 BACKDRAFT DAMPERS / RELIEF DAMPERS

.1 Automatic gravity operated multi leaf construction with nylon bearings, spring assisted or counterweighted, as required. Dampers will be constructed from the same material as the ductwork in which it is installed.

.2 Backdraft dampers will be designed to operate to the full open position at 50 Pa (0.2”SP).

.3 Relief Dampers will relief positive pressure of 25 Pa (0.1”SP).

2.7 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer’s to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Fire Dampers	Metalaire, NCA, Ruskin, Ventex
.2 Multi leaf Dampers	Metalaire, NCA, Ruskin, Ventex
.3 Backdraft Dampers	Metalaire, NCA, Ruskin, Ventex
.4 Insulated Multi Leaf Dampers	Tamco, Nailor
.5 Actuators	Belimo, Siemens

.6 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 GENERAL

.1 Install in accordance with recommendations of SMACNA.

.2 Seal multiple damper modules with silicon sealant.

.3 Install access door adjacent to each damper. Ensure dampers are observable and accessible.

.4 Review installation with relevant sub-contractors to insure the performance requirements can be met.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 FIRE DAMPER INSTALLATION

.1 Install in accordance with the conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.4 Install access door adjacent to each damper.

.5 Coordinate with installer of fires topping.

.6 Ensure access doors/panels, fusible links and damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

.8 Dampers will be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

3.4 BALANCING DAMPER INSTALLATION

.1 Install where indicated and as required for completion of balancing.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper shaft extensions/ operators are observable and accessible.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section specifies fans, motors, accessories and hardware for the project.

1.2 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) Testing Standards:

- .1 ANSI/AMCA Standard 99, Standards Handbook.
- .2 ANSI/AMCA Standard 204 - Balance Quality and Vibration Levels for Fans.
- .3 ANSI/AMCA Standard 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- .4 ANSI/AMCA Standard 320 - Laboratory Methods of Sound Testing of Fans Using Sound Intensity.

.3 Air Movement and Control Association International, Inc. (AMCA) Certified Ratings Program:

- .1 AMCA Publication 111 - Laboratory Accreditation Program Outlines Procedure for Obtaining AMCA International Recognition of a Laboratory.
- .2 AMCA Publication 11 - Certified Ratings Program Operating Manual.
- .3 AMCA Publication 211 - Certified Ratings Program - Product Rating Manual for Fan Air Performance.
- .4 AMCA Publication 212 - Certified Ratings Program - Product Rating Manual for Smoke Management Fan Performance.
- .5 AMCA Publication 311 - Certified Ratings Program - Product Rating Manual for Fan Sound Performance.
- .6 AMCA Standard 205, Energy Efficiency Classification for Fans.
- .7 AMCA 201 - Fans and Systems.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:

- .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data will include all relevant information to confirm the specifications have been met.
- .5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data will include any relevant information which Division 25 requires for a properly functioning building automation system.

.8 Product data will include information as specified in 20 01 01 Common Work Results – Mechanical unless modified with additional information required below.

.9 Additional information required.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.

.2 Maintenance data will include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer's maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.4 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 MAINTENANCE REQUIREMENTS

.1 Contractor will verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 Contractor will supply the following materials to site just prior to substantial being awarded:

.1 Provide one set of V belts for each belt drive fan.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment will bear a CSA label or have an ESA certification.

.3 Air moving equipment will bear an AMCA label.

.4 Where applicable equipment will bear a ULC or UL label.

.5 All fans prior to shipment will be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel will be statically and dynamically balanced. Fans balance readings maintained and a written copy will be available upon request.

1.6 COMMISSIONING

.1 The manufacturer and/or their factory representative will participate in the commissioning process. The manufacturer will inspect the final installation and verify that the product has been installed as per the manufacturer's instructions. The manufacturer will report compliance or discrepancies directly to the Consultant.

PART 2 - PRODUCTS

2.1 GENERAL

.1 All fan performance ratings will conform to AMCA Standard 205 (fan efficiency grade) and 211 (air performance). Fans will be tested in accordance with ANSI/AMCA Standard 210 (air performance) and 300 (sound performance) in an AMCA accredited laboratory. Fans will be licensed to bear the AMCA certified ratings seal for air and fan efficiency grade (FEG).

.2 All fans will bear a permanently attached nameplate displaying model and serial number of the unit for future identification.

.3 Fans will meet or be lower than maximum sound data as listed on the drawings.

.4 The contractor will coordinate the installation of fans with Division 25, Controls Contractor to ensure that the system can be controlled as per the performance requirements.

2.2 COMMERCIAL CABINET DUCT BLOWER IN-LINE CENTRIFUGAL FANS FORWARD CURVED DWDI

.1 Application: Standard supply / return / exhaust air at standard temperature and humidity.

.2 Description:

.1 DWDI (Double Width, Double Inlet) Forward Curved type fan mounted within a cabinet for in line airflow, interior mounting.

.2 Performance: as indicated on drawings and schedule.

.3 Construction:

.1 Cabinet assembly will be heavy-gauge galvanized steel, lock seam, construction. Duct collars for duct attachment and removable side panels for service access. Cabinet will be finished with an enamel paint coating.

.2 Cabinet will be insulated with 25 mm (1") thick fiberglass foil faced insulation.

.3 Fan will be forward curved, galvanized steel, Class 1 construction. Wheel will be statically and dynamically balanced. Fans will be equipped with self-aligning ball bearings, permanently lubricated and sealed.

.4 Supply air position will be adjustable from right angle to straight through with interchangeable panels.

.5 Motor and Drive: fan will be direct drive or belt drive as indicated. Motor will be permanent split capacitor with built-in thermal overload protection and disconnect plug. Motor will conform to applicable sections of NEMA Standard MG-1. Motors will bear a CSA / UL label. Motors will be capable of adjustable speed and provided with a speed controller if required.

.6 Unit will be supplied with integral wiring box and receptacle and disconnect receptacle. Factory mounted and wired NEMA-rated disconnect switch.

.4 Accessories (supplied by Fan Manufacturer):
- .1 Internal fan housing mounting with flexible duct connection to cabinet and internal spring or neoprene type vibration isolators.
- .2 Speed controller.
- .3 Disconnect switch.

2.3 RESIDENTIAL CEILING MOUNTED CENTRIFUGAL FANS FORWARD CURVED

.1 Application: standard exhaust air from a single space, at standard temperature and humidity.

.2 Description:
- .1 SWSI (Single Width, Single Inlet) Forward Curved type fan mounted within a cabinet for in line airflow, interior ceiling mounting.
- .2 Performance: as indicated on drawings and schedule.

.3 Construction:
- .1 Cabinet assembly will be galvanized steel, lock seam, construction.
- .2 Fan will be forward curved, galvanized steel. Wheel will be statically and dynamically balanced.
- .3 Motor and Drive: fan will be direct drive. Motors will be permanently lubricated and mounted with resilient anti-vibration mounts. Motors will be capable of adjustable speed.
- .4 Field wiring compartment with disconnect receptacle.
- .5 Adjustable pre-punched mounting bracket to accommodate varying ceiling thickness.
- .6 Painted white enamel aluminum ceiling mounted exhaust grille.

.4 Accessories (supplied by Fan Manufacturer):
- .1 Internal fan housing mounting with flexible duct connection to cabinet and internal spring or neoprene type vibration isolators.
- .2 Speed controller.
- .3 Disconnect switch.

2.4 COMMERCIAL PROPELLER FANS – WALL MOUNTED

.1 Application: standard air at standard temperature and humidity.

.2 Description:
- .1 Propeller style axial fan blades mounted on a panel exposed within the space.
- .2 Performance: as indicated on drawings and schedule.

.3 Construction:
- .1 Fan panels and motor mount assemblies will be constructed of heavy gauge steel. Panels will have a deep formed inlet Venturi for aerodynamic airflow into the fan. Motor and bearing supports will be constructed of heavy-gauge steel and will be suitably braced to prevent vibration or pulsation.
- .2 Fan blades will be of an airfoil shape for higher efficiency. Blades and wheel rotor impellor will be constructed of fabricated steel and blades will be securely attached to the hub. Hub and blades will be statically and dynamically balanced.
- .3 Shafts will be hot rolled steel, mounted on pillow block bearings, heavy duty, grease lubricated, anti-friction ball, self-aligning type.
- .4 Finish – enamel corrosion resistant paint finish. Aluminum components will be unpainted.

.4 Motor and Drive:

.1 Fan will be direct drive as shown on the drawings.

.2 Motor will conform to applicable sections of NEMA Standard MG-1. Motors will bear a CSA / UL label.

.3 Motors will be capable of adjustable speed and provided with a speed controller if required.

.4 Motors will be explosion proof where specified.

.5 Factory mounted and wired NEMA-rated disconnect switch.

.5 Accessories (supplied by Fan Manufacturer):

.1 Wall mounting collar.

.2 Motorized damper and damper guard screen.

.3 Wall collar louvers mounted flush with exterior wall.

.4 Spiral plated Inlet Motor Guard Screen, OSHA compliant.

.5 Speed controller.

.6 Disconnect switch.

2.5 COMMERCIAL ROOF MTD CENTRIFUGAL SPUN ALUMINIUM EXHAUST FAN

.1 Application: standard exhaust air at standard temperature and humidity.

.2 Description:

.1 Plug fan style, backward inclined type fan mounted within a spun aluminum housing, with integral roof curb mounting frame for exterior mounting.

.2 Performance: as indicated on drawings and schedule.

.3 Construction:

.1 Housing assembly will be a spun aluminum dome with rolled bead edge for rigidity. Dome will cover aluminum base with a deep Venturi inlet to prevent snow and rain entry into the building. Entire assembly will direct mount to a roof curb, provide roof curb gasket. Lifting lugs will be provided.

.2 A two piece top cap will have stainless steel quick release latches to provide access into the motor compartment without the use of tools.

.3 Fan will be backward inclined, aluminium, Class 1 construction. Wheel will be statically and dynamically balanced. Fans will be equipped with self-aligning ball bearings, permanently lubricated and sealed.

.4 Heavy-duty cast iron adjustable pulleys to permit balancing and speed adjustment.

.5 Motor and Drive: fan will be belt drive as indicated. Motors will be TEFC (Totally Enclosed Fan Cooled), squirrel-cage induction motors, premium efficiency severe duty type, NEMA Design B. Having a minimum service factor of 1.15 (continuous). Motor will conform to applicable sections of NEMA Standard MG-1. Motors will bear a CSA / UL label. Motors will be capable of adjustable speed and inverter duty.

.6 Power to the fan will be thru the roof curb assembly and a conduit chase constructed of EMT will be provided to the motor compartment. Provide a factory mounted and wired NEMA-rated disconnect switch.

.7 Fan will be equipped with backdraft damper to be mounted within curb at inlet to fan. Fan discharge will be equipped with a bird screen.

.4 Roof curb will be factory supplied for applicable roof construction, roof curb will be minimum 600 mm (24") high and have insulated and weatherproofed walls.

.5 Accessories (supplied by Fan Manufacturer):
- .1 Gasketted access door in housing.
- .2 Weatherproof motor and belt guard.
- .3 Spark resistant construction.
- .4 Protective coating.
- .5 Disconnect switch.

2.6 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Commercial Cabinet Centrifugal Blowers	Cook, Penn Berry, Greenheck
.2 Ceiling Washroom Exhaust Fan	Cook, Penn Berry, Greenheck
.3 Wall Mounted Propeller Fans	Cook, Penn Berry, Greenheck
.4 Spun Aluminum Upblast Roof Exhauster	Cook, Penn Berry, Greenheck
.5 JLR Specified Products and bases of design:	Nil

PART 3 - EXECUTION

3.1 GENERAL

.1 Carry out field inspection on arrival at site, check for structural damage and verify that electrical characteristics, unit capacities and options are as specified.

.2 Coordinate roof, wall and ceiling openings, locations and sizes and positioning of roof curbs with other trades.

.3 Make all adjustments necessary to meet specified airflow. Provide belts and pulleys required for final balancing. Coordinate with the TAB (Testing Adjusting and Balancing) Contractor.

3.2 MANUFACTURER'S INSTRUCTIONS

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section describes the minimum performance and build quality of air terminal units.

1.2 REFERENCES

.1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
- .1 ANSI/ASHRAE 51-07 (ANSI/AMCA 210-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.2 International Organization of Standardization (ISO)
- .1 ISO 3741-2010, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.

.3 National Fire Protection Association (NFPA)
- .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.

.4 Underwriter's Laboratories (UL)
- .1 UL 181-2005(R2008), Factory-Made Air Ducts and Air Connectors.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data will include all relevant information to confirm the specifications have been met.
- .5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
- .7 Product data will include any relevant information which Division 25 requires for a properly functioning building automation system.
- .8 Product data will include information as specified in 20 01 01 Common Work Results – Mechanical unless modified with additional information required below.
- .9 Additional information required.

.3 Shop Drawings:
- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Pressure drop.

.3 Noise rating.
.4 Leakage.
.5 Control schematics.

.4 Maintenance Data:
.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Close-out.
.2 Maintenance data will include but not be limited to:
.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.
.2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.
.3 The manufacturer's maintenance and installation data.
.4 Safety informational data for maintenance staff prior to performing maintenance requirements.
.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.
.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.5 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

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

.7 Test and Evaluation Reports:
.1 Test data: to ANSI/AMCA Standard 210.
.1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
.2 Sound power level with inlet pressures of up to 0.75 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.

1.4 COMMISSIONING

.1 The manufacturer and/or their factory representative will participate in the commissioning process. The manufacturer will inspect the final installation and verify that the product has been installed as per the manufacturer's instructions. The manufacturer will report compliance or discrepancies directly to the Consultant.

PART 2 - PRODUCTS

2.1 SINGLE DUCT AIR TERMINAL UNIT – INTEGRAL ATTENUATOR AND HOT WATER REHEAT

.1 Basic unit
.1 Furnish and install Single Duct Air Terminal Units. The units will be the size and capacity as outlined in the schedule. Casing dimensions will be checked to ensure the terminals fit the available space.

.2 Quality and Standards

.1 Air terminals will be certified under the Air Conditioning, Heating and Refrigeration Institute (AHRI) Standard 880-08 Certification Program and carry the AHRI seal. All NC values will be calculated per AHRI Standard 885-08. Units with NC values calculated per AHRI-885-90 or 98 will not be accepted. Terminal units will be either ETL® or UL® listed as a complete assembly. Terminal electrical components, including actuators and low voltage controls will be UL® listed. All electrical components including both line voltage and low voltage will be mounted in a metal control enclosure. Units will have a single point field wiring connection. Units will be manufactured and wired per UL-1995 and in accordance with the National Electric Code.

.3 Shipping

.1 All terminals will be shipped as a single unit requiring no field assembly. Accessories including hot water coils and electric heaters will be factory mounted.

.4 Casing

.1 The air terminals will be constructed of galvanized steel. The casing will be a minimum of 22-gauge. The terminal primary air inlet valve will have a round (oval or rectangular for larger sizes) inlet for field duct connection. The terminal unit discharge will allow for a slip and drive duct connection. Units will have a universal control-mounting panel constructed of minimum 22-gauge steel. Control panel will include stand-offs to allow controls to be mounted without penetrating the terminal casing. Control panels without stand-offs are not acceptable.

.5 Primary Inlet Air Valve

.1 Inlet tube:

.1 Primary inlet air valve assembly will have a seamless butt weld on round inlet tube to minimize leakage and prevent the damper from binding on overlapping seam welds. Inlet tubes with overlapping welds or non- continuous, skipped welds are not acceptable. Inlet air valve will have three structural beads machine formed into the tube. One external bead will be provided for the attachment of flexible duct. Inlet air valves without three structural beads are not acceptable.

.2 Flow sensor:

.1 Primary inlet air valve flow sensor will be multi-quadrant averaging sensor with flow sampling of both velocity pressure and flow differential pressure from four quadrants, and will contain two control ports and two accessory ports. Flow sensors sampling only velocity pressure in all four quadrants are not acceptable. Sensors reading differential pressure with fewer than 8 measuring points are not acceptable. All piping connections to the flow sensor must be made with external ports that extend through damper tube. Units with piping connections made in the primary air stream are not acceptable. Flow sensors with plastic piping connections of any kind are not acceptable. At an inlet velocity of 2000 fpm, the differential static pressure required to operate any terminal size will not exceed 0.14” wg. for the basic terminal.

.1 Inlet flow sensing devices will be provided with a gasketed access door to permit removal, inspection and cleaning of the air flow sensor.

.3 Damper assembly

.1 Damper shaft will rotate in a self-lubricating, long life, low friction thermo-plastic bearing. Damper shaft construction will be one piece, continuous extruded aluminum. Damper shaft end will include a permanent cast damper position indicator. Damper tube will be free of obstructions including damper stops to allow the free rotation of the damper. Mechanical damper stops located in the inlet tube are not acceptable. A flexible gasket-mounted damper blade without adhesives will provide damper seal.

Damper gasket will include slit partitioning around the perimeter to prevent damper noise at low flows near full close off. Damper gaskets without perimeter slit partitioning are not acceptable. Mechanically fastened damper assembly will be double layer, 18 gauge equivalent, galvanized steel with integral blade seal. Leakage through the damper assembly will be less than 1% of maximum CFM at 3" static pressure.

.6 Insulation

.1 Air Terminals will be internally insulated with or 1" thick, 1.5 lb. /ft3, dual density fiberglass. Insulation and edges will be coated to prevent air erosion to 6000FPM surface velocity. Insulation will comply with UL 181 and NFPA 90A.

.7 Hot Water Coils

.1 Hot Water Coils are to be factory mounted to the discharge outlet of the terminal. The number of rows and circuits will meet the capacities as shown in the schedule. Hot water coils will be enclosed in a minimum 20-gauge coated steel casing allowing attachment to metal ductwork with a slip and drive connection. Fins will be rippled and sine wave type, constructed from heavy gauge aluminum, and mechanically bonded to the tubes. Tubes will be copper with a minimum wall thickness is 0.016" with male sweat header connections.

.2 Coils will be leak tested to 300 psi with minimum burst of 2000 psi at ambient temperature. Coil performance data will be rated and presented in accordance with AHRI standard 410. Coils must be ARI rated, certified and include an AHRI label. Coils that are not AHRI rated, certified or labeled AHRI are not acceptable.

.8 Access Panels and Mounting

.1 Provide separate bottom primary inlet access panel

.2 Terminal will include 3" wide bottom-mounting surfaces on opposite ends designed to accept bottom-mounting hardware including trapeze type. Bottom-mounting surfaces will allow mounting hardware to be installed without interfering with access or removal of the bottom access panels.

.9 Sound

.1 The terminal manufacturer will provide AHRI certified sound power data for radiated and discharge sound. All NC values will be calculated per AHRI standard 885-98. Verify sound ratings for the terminal do not exceed specified value at scheduled static pressure. Sound performance will be AHRI certified. Each individual terminal unit will bear an AHRI label.

.2 Sound attenuator will be provided where scheduled to meet acoustical performance requirements. The attenuator and terminal unit will be single piece construction. Attenuator insulation will be the same as the unit casing insulation.

.10 Controls

.1 Factory mounting and wiring of DDC controls will be as specified in the schedule. Mounting will include manufacturer's flow sensor, transformer, and an enclosure protecting DDC controls and wiring.

2.2 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Single Duct Air Terminal Unit — Cook, Price, Nailor

.2 JLR Specified Products and bases of design: — Nil

PART 3 - EXECUTION

3.1 APPLICATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air terminal units' installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in the presence of Departmental Representative.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Consultant.

3.2 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of ductwork.

.3 Install with at least a minimum of four duct diameters of straight inlet duct length, the same size as the inlet.

.4 Locate controls, dampers and access panels for easy access.

3.3 CLEANING

.1 Progress Cleaning: seal ends of terminal units to prevent dust from settling inside the terminal unit and on sensors.

.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 01 – Cleaning.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

.1 ASTM International
- .1 ASTM E 90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.2 National Research Council Canada (NRC)
- .1 National Building Code of Canada 2015 (NBC).

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 01 – Submittal Procedures.

.1 Product Data:
- .1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Indicate following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.2 Provide maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.

.3 Include:
- .1 Keys for volume control adjustment.
- .2 Keys for air flow pattern adjustment.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 -–Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
- .1 Store materials off in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.2 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.

.2 Frames:
- .1 Full perimeter gaskets.
- .2 Plaster frames where set into plaster or gypsum board and as specified.
- .3 Concealed fasteners.

.3 Concealed manual volume control damper operators.

.4 Colour/Finish: As indicated on drawings.

2.3 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 SUPPLY GRILLES AND REGISTERS

.1 General: with opposed blade dampers.

.2 Type E: as indicated on drawings.

2.5 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 General: with opposed blade dampers.

.2 Type B: as indicated on drawings.

.3 Type C: as indicated on drawings.

.4 Type D: as indicated on drawings.

.5 Type F: as indicated on drawings.

2.6 DIFFUSERS

.1 General: volume control dampers with flow straightening devices and gaskets.

.2 Type A: as indicated on drawings.

2.7 LINEAR DIFFUSERS

.1 Air volume control damper with concealed adjustment.

.2 Type G: as indicated on drawings.

2.8 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1	Supply Grilles and Registers:	Metalaire, Nailor, Krueger
.2	Return and Exhaust Grilles and Registers:	Metailaire, Nailor, Krueger
.3	Diffusers:	Metalaire, Nailor, Krueger
.4	Linear Diffusers:	Metalaire, Nailor, Krueger

.3 JLR Specified Products and bases of design:

.1 Nil

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Install with flat head screws in countersunk holes where fastenings are visible.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

.1 ASTM International
- .1 ASTM E 90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.2 National Research Council Canada (NRC)
- .1 National Building Code of Canada 2015 (NBC).

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Indicate following:
  - .1 Pressure drop.
  - .2 Face area.
  - .3 Free area.

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

.4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E 90.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect louvers, intakes and vents from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GRAVITY ROOF OUTSIDE AIR INTAKES AND RELIEF VENTS

.1 Factory manufactured aluminum hinged at curb line.

.1 Complete with integral birdscreen.

.2 Backdraft damper.

.3 Maximum throat velocity: 2.5 m/s.

.4 Maximum loss through unit: 15 Pa static pressure.

.5 Maximum velocity through damper area: 1.5 m/s.

.6 Shape: as indicated.

.2 Birdscreens:

.1 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust and 19 mm mesh on intake.

2.3 FIXED LOUVRES - ALUMINUM

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

.4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

.5 Mullions: at 1500 mm maximum centres.

.6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

.7 Screen: 12 mm exhaust and 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.8 Finish: factory applied enamel, prime coated. Colour: as indicated or approved by Consultant.

2.4 FIXED LOUVRES

.1 Refer to Division 9.

2.5 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Fixed Louvres: Ventex, Tamco

.2 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 INSTALLATION

.1 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION SUMMARY

.1 This section describes the pumps requirements for HVAC heat exchangers.

1.2 REFERENCES

.1 Unless dated references are identified below, it will be the latest standard issued by the regulatory agency that will be utilized as the applicable reference.

.2 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE):
- .1 Standard 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings.

.3 American Society of Mechanical Engineers (ASME)
- .1 ASME Boiler and Pressure Vessel Code, 2010.

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

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data will include all relevant information to confirm the specifications have been met.
- .5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
- .7 Product data will include any relevant information that Division 25 requires for a properly functioning building automation system.
- .8 Product data will include information as specified in Section 20 01 01 – Common Work Results for Mechanical unless modified with additional information required below.

.3 Maintenance Data:
- .1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 00 – Closeout Procedures.

.2 Maintenance data will include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer's maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

1.4 MAINTENANCE REQUIREMENTS

.1 Contractor will verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 Contractor will supply the following materials to site just prior to substantial being awarded.

.1 Provide one replacement filter for each installed filter.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment will bear a CSA label or have an ESA certification.

.3 Where applicable equipment will bear a ULC or UL label.

.4 Provide and construct mock-ups in accordance with Section 01 45 01 – Quality Control.

1.6 COMMISSIONING

.1 General: in accordance with Sections 01 91 01 – Commissioning, 23 08 02 – Commissioning – Cleaning and Start-up of Mechanical Systems.

.2 In accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 FLOODED HEAT EXCHANGER

.1 Packaged Unit: complete with heat exchanger, condensate control valves, steam traps, necessary interconnecting piping, fittings and valve for condensate discharge, and necessary interconnecting piping, fittings, isolation valves, gauges and transmitter/switches on hydronic header manifold assemblies all mounted on a steel frame and support base. Package unit shall be constructed to allow disassembly for component delivery to mechanical room.

.2 Heat exchangers: shell & coil type completely welded with heated liquid medium in shell and steam/condensate through coils, 316L stainless steel shell with hemi-spherical heads, 316L 150# flanged connections, internal 316L helically corrugated coiled bundle tubes welded to 316L tube sheet, oversized to maximize sensible heat extraction, pressure/temperature ratings of 150 psig and 366°F. Designed, tested and manufactured in accordance with ASME Section VIII Div. 1 and from an ISO 9001 manufacturing shop and be CRN registered.

.3 Condensate Control Valves:

.1 Valve: carbon steel body, contour top guided or multi-hole cage guided, stainless steel valve, stainless steel valve seat and stem, V-Teflon gland packing up to 366ºF, grafoil gland packing above 366ºF, screwed NPT end connections up to size 2” NPS and flanged end connections for sizes 2½” to 6” NPS, 450ºF maximum operating temperature, 300 PSIG maximum operating pressure, equal percentage flow, ANSI Class IV leakage, 50:1 rangeability.

.2 Electric Actuator: proportional modulation, capability for custom configuration, zinc coated metal and plastic casing NEMA type 2 / IP54 housing mounted in any orientation, painted steel mounting bracket, input 4-20mA 2-10 Vdc signal from BAS, reversibility with built-in switch, visual position indicator, manual override for actuator position, fail-safe Mechanical, spring-return mechanism, 2-10V VDC feedback output, maximum 10 VA at 24-V AC or 8 W at 24-V DC power requirements, ISO 9001, cULus, and CSA C22.2 No. 24-93.

.4 Main Steam Trap: float and thermostatic steam trap and shall be CRN registered.

.5 Overflow Steam Trap: thermodynamic trap complete with integral strainer and shall be CRN registered.

.6 Check Valve: spring-assisted non-slam type in 316 stainless steel construction including valve seat and disc, CRN registered.

.7 Provide cast iron suction guide at the inlet of each pump complete with fine mesh screen, blow down connection, permanent magnet particle trap, full length straightening vanes and pressure gauge tappings.

.8 Provide triple-duty balancing, check and isolation valve assembly installed on the discharge of each pump. Body shall be cast iron, bronze disc and EPDM seat, stainless steel stem, two brass body metering ports and two ¼” NPT drain tappings.

.9 Air separator with integral strainer installed upstream of the pump suction guide. Air separator from size 2" to 3" shall come with threaded NPT tangential connections. Air separator from size 4" to 24" shall come with ANSI 150# RFSO flanged tangential connections. All separator sizes shall be designed and built in accordance with ASME Section VIII, Div. 1. Unit size from 2" to 6" shall be made of cast iron. All size shall come with a blowdown connection provided for routine cleaning of the unit.

.10 Fixed pivot ball float liquid air vent shall be installed on the air separator. The vent body shall be cast iron, valve, seat, leverage system and float shall all be in stainless steel. Design pressure/temperature shall be 250 psi / 450 ºF.

.11 Manual lugged style resilient seated bi-directional butterfly valve shall be installed at both liquid inlet and liquid outlets of each pump and each heat exchanger. Valve stem construction shall be 416 stainless steel and disc shall be 304 stainless steel. Molded-in resilient seat must provide bubble-tight shutoff up to 250 psi.

.12 Premium stainless steel liquid filled pressure gauge shall be installed on both liquid inlet and liquid outlets. Gauge must have a 4" dial face, stainless steel case and stainless steel internal, filled with glycerin and provide ±1% accuracy. Pressure gauge installed on steam shall be protected by a 180 degree coil siphon made of 304 stainless steel seamless schedule 40 good for a working pressure of 500 psi @ 680 ºF. Both pressure gauge and siphon shall be CRN registered.

.13 Bi-metal thermometer shall be installed on both liquid inlet and liquid outlets. Thermometer must have 4" dial stainless steel case and stem, fixed centre back connection, dual scale (ºF & ºC) and provide ±1% accuracy. Thermometer shall be connected in either a brass or stainless steel thermowell.

.14 Piping shall be hydrostatically tested at the factory prior to shipping.

.15 Piping and frame shall have high heat resistance black paint with temperature capacity to 800 ºF.

.16 Standard material specifications :

.1 Steam piping in carbon steel schedule 40 ASTM-A53 grade B ERW

.2 Condensate piping in carbon steel schedule 80 ASTM-A53 grade B ERW

.3 Water/glycol piping in carbon steel schedule 40 ASTM-A53 grade B ERW

.4 Carbon steel flanges ASME B16.5 SA-105

.5 Carbon steel threaded fittings ASME B16.11 SA-105 3000#

.6 Carbon steel butt weld fittings ASME B16.9 SA-234 WPB

.7 Carbon steel union MSS-SP-83 SA-105 3000#

.8 Metallic gaskets ASME B16.20 316L (steam/condensate)

.9 Non-metallic gaskets PTFE (liquid)

.10 Studs black ASME SA-193 B7 / Hex nuts black ASME SA-194 2H

.11 Steel structure ANSI I-Beam S 3x7.5 44W and ANSI HSS A-500 C 1/4" tk. rect./square tube

.17 RTD shall be 3-wire platinum type with 316 stainless steel probe complete with NEMA 4 aluminum head and installed on hydronic supply header outlet assembly complete with 316 stainless steel thermowell.

.18 Flow switch shall be general purpose duty 120/240VAC for liquid flow installed on hydronic outlet of pumps before heat exchangers complete with single pole, double throw snap switch, stainless steel paddle, hardened stainless steel bearings, sealed monel bellows, sensitivity adjustment screw and 1” NPT connection.

.19 Provide shop drawings in 3D, including a detailed bill of materials, connections sizes table, operating conditions table and a complete specifications package of every component.

2.2 IN-LINE CENTRIFUGAL PUMPS

.1 The pump (s) will be in line type, close coupled, single stage design. Pumps will be capable of mounting in the vertical position. Provide pumps in accordance with scheduled performance criteria.

.2 Pump will be rated for a minimum of 1207 kPa (175 PSI) working pressure. The housing will be hydrostatically tested to 150% maximum working pressure.

.3 Construction:

- .1 Volute and Frame Casing: cast ductile iron construction, with flanged inlet and discharge with integrally cast support. Suction and discharge will be provided with drilled and tapped seal vent and pressure gauge connections. Casing will be radially split to allow for removal of the rotating element without disturbing pipe connections.
- .2 Impellor: impeller will be machined cast bronze, enclosed type, statically and hydraulically balanced. Impeller will be keyed to the shaft and secured by a hex head impeller nut and washer.
- .3 Pump Shaft: alloy steel shaft with bronze sleeve bearing.
- .4 Seals: mechanical shaft seals for leak less operation. Seal will be internally flushed and a portion of the pumped liquid will be utilized to lubricate and cool the seal faces.
- .5 Fittings: provide vent, and gauge connections.

.4 Motor: motor will be premium-efficiency squirrel cage induction type motors and suitable for across-the-line (wye-delta, part wind) starting. Motors will also be capable of invertor duty and variable speed operation. The motor will be TEFC (totally enclosed, fan cooled), meet NEMA specifications and will be the RPM, size (HP), and voltage as indicated. Pump and motor will be factory aligned, and verified by the contractor following installation and realigned if required.

.5 Variable Frequency Drive (VFD) to be provided by the manufacturer listed in Section 2.3 of this specification.

.6 Each pump will be factory tested and painted with at least one coat of high-grade machinery enamel prior to shipment.

2.3 AIR SEPARATORS

.1 Cyclonic Air Separator:

- .1 Provide centrifugal type air separator with strainer.
- .2 Unit to be fabricated of steel to ASME ratings for 860 KPa (125 PSI).
- .3 Unit to have flanged or grooved inlet and outlet connections and separate top connection for venting and bottom connection for blowdown

2.4 PIPING

.1 All piping and devices shall me the requirements

- .1 23 21 13 Hydronic Piping
- .2 23 21 19 Hydronic Specialities

2.5 WIRING AND CONTROLSCONTROLS

.1 The supplier shall co ordinate the equipment assembly with Div 25. The assembly shall include thermowells for all devices required for complete control of the package by Div 25.

.2 The supplier shall not include any controls within the package

.3 The package shall include power wiring from the VFD and the pump mpotor.

2.6 VARIABLE FREQUENCY DRIVES

.1 Each motor in the package will be equipped with a Variable Frequency Drive, rated for the equipment supply voltage.

.2 Operating Conditions

.1 All VFD's must be suitable for operation within an ambient temperature range of -10 - 50ºC (14 - 122ºF)

.2 Humidity: VFD's must be capable of withstanding operation in environments with humidity of maximum 95% non-condensing.

.3 Input Frequency: VFD's shall be capable of operating with a mains supply frequency range of 50 – 60Hz ± 2%.

.4 Output Frequency: The VFD shall be capable of variable frequency, variable voltage output in the range 0 – 500Hz and 0 – Supply Voltage. Frequency resolution must be at least 0.1Hz

.5 VFD's shall be capable of controlling and correctly protecting the motors throughout the required frequency range.

.6 VFD's should include protection features to ensure that the motor may not operate in an overloaded condition which may cause damage to the connected motor.

.7 VFD's shall be selected based on the full load operating current of the motor. No under sizing of the VFD is permitted, nor should any over sizing be necessary.

.8 VFD's shall be capable of controlling the motor with a constant or variable torque output characteristic in order to operate the desired load. Selection between constant and variable torque operation should be easily selectable by parameters within the VFD.

.9 VFD's shall be capable of operating with High Efficiency motors of classes IE2, IE3 and IE4.

.10 The product data label will carry the UL/CUL standard logo.

.11 Harmonics

.1 VFD's shall be of a low harmonic design, and shall provide compliance with EN61000-3-12 for units in the range where input current >16A and ≤75A per phase

.2 Inverters up to 45kW for use on 3 Phase supplies shall utilise film capacitors in the DC link, to minimise harmonic distortion without the need for AC or DC chokes

.12 EMC: All VFD's will be available with inbuilt EMC filters as standard.

.13 Bypass

.1 The VFD is required to be supplied with functionality able to control a three contactor bypass circuit / configuration.

.2 The VFD will be capable of automatically selecting bypass control in the event of a VFD trip condition.

.3 The VFD will be capable of selecting bypass or VFD control based on a digital input to the VFD.

.4 The VFD will be serviceable while in Bypass mode.

.14 Control Functions: All VFD programmable parameters to be adjustable from digital operator keypad located on front door of VFD Parameters to include:

.15 VFDs to have following system interfaces:

.1 Inputs:

.1 Process control speed reference interface to receive either a 0-10 Vdc, 4-20 mA dc or speed potentiometer signal.

.2 Remote mode start and stop contacts.

.3 Remote forward/reverse contacts.

.4 Remote preset speed contacts.

.5 Remote external trip contact.

.6 Remote reset contact.

.7 Remote jog contact.

.2 Outputs:

.1 Programmable digital relays (2), NO contact.

.2 Form C contact to indicate protective function trip.

.3 Two (2) programmable analog output signals.

2.7 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Flooded Heat Exchanger: Preston Phipps, Spirax Sarco

.2 Control Valves: Siemens

.3 Variable Speed Drives Seimens, ABB

.4 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 INSTALLATION

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

.2 General: install level and firmly anchored to supports as in accordance with manufacturer's recommendations.

.3 Arrange piping so that tube bundle can be removed after disconnecting two unions or flanges adjacent to head and without disturbing other equipment and systems.

3.2 APPURTENANCES

.1 Install with safety relief valve piped to drain.

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

.3 Install pressure gauge on steam inlet.

3.3 FIELD QUALITY CONTROL

.1 Site Tests and Inspections:

.2 Perform tests as directed by the Consultant to ensure heat exchangers are functional.

.1 Obtain reports within 3 days of review and submit immediately to the Consultant.

.3 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.

.4 Manufacturer's Field Services:

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

.2 Ensure manufacturer's representative is present before and during critical periods of installation and testing.

.3 Schedule site visits:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

3.4 SYSTEM START-UP

.1 General: perform start-up operations in accordance with Section 01 91 01 - Commissioning : General Requirements, supplemented as specified herein.

.2 Check heater for cleanliness on primary and secondary sides.

.3 Check water treatment system is complete, operational and correct treatment is being applied.

.4 Check installation, settings, operation of relief valves and safety valves.

.5 Check installation, location, settings and operation of operating, limit and safety controls.

.6 Check supports.

.7 Timing: only after TAB of hydronic systems have been successfully completed.

.8 Primary side:

.1 Measure flow rate, pressure drop, and steam pressure and temperature at heater inlet.

.1 Verify operation of steam traps. Measure temperature of condensate return at trap outlet.

.2 Control valve: verify proper operation without binding, slack in components. Measure steam pressure and temperature at control valve inlet.

.3 Secondary side:

.1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.

.2 Verify installation and operation of air elimination devices.

.4 Calculate heat transfer from primary and secondary sides.

.5 Simulate heating water temperature schedule and repeat above procedures.

.6 Verify settings, operation, safe discharge from safety valves and relief valves.

.7 Verify settings, operation of operating, limit and safety controls and alarms.

.8 Reports:

.1 In accordance with Section 01 91 01 - Commissioning.

3.5 DEMONSTRATION

.1 Training: provide training in accordance with Section 01 91 01 - Commissioning.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by heat exchanger installation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section describes the minimum performance and build quality of air handling units designed and manufactured to the specific requirements of this project.

1.2 REFERENCES

.1 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
- .1 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .2 ANSI/ASHRAE/IES 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Green Seal (GS)
- .1 GS-11-11, Standard for Paints and Coatings.

.3 Master Painters Institute (MPI)
- .1 Architectural Painting Specification Manual - current edition.
  - .1 MPI #18.

.4 National Fire Protection Association (NFPA)
- .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.

.5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)

.6 South Coast Air Quality Management District (SCAQMD)
- .1 SCAQMD Rule 1113-11, Architectural Coatings.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data will include all relevant information to confirm the specifications have been met.
- .5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data will include any relevant information which Division 25 requires for a properly functioning building automation system.

.8 Product data will include information as specified in 20 01 01 Common Work Results – Mechanical unless modified with additional information required below.

.9 Additional information required.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario Canada.

.2 Indicate on drawings:

.1 Actual cooling and heating fluid entering and leaving conditions for stated air side requirements.

.2 Product data shall indicate dimensions, weights, capacities, ratings, fan performance, motor electrical characteristics, metal gauges and finishes of materials.

.3 Provide fan curves with specified operating point clearly plotted.

.4 Submit sound power levels for both fan inlet and outlet at rated capacity. Provide sound power levels at the inlet and outlet of the unit.

.5 Submit product data of filter media, filter performance data, filter assembly, and filter frames.

.6 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

.4 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.

.2 Maintenance data will include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer’s maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.5 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

.6 Contractor will supply the following materials to site just prior to substantial being awarded:

.1 Provide one set of V belts for each belt drive fan.

.7 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment will bear a CSA label or have an ESA certification.

.3 Air moving equipment will bear an AMCA label.

.4 Where applicable equipment will bear a ULC or UL label.

.5 All fans prior to shipment will be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel will be statically and dynamically balanced. Fans balance readings maintained and a written copy will be available upon request.

.6 The following are to be used as selection criteria and are to be as specified: Air flow rates, external static pressures, water flow rates. The following are to be equaled or bettered: Coil face velocities, filter face velocities, casing leakage rates. The following are to be met within 10% of specified values: Water pressure drops.

.7 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock.

.8 Air handling units and major components shall be products of the manufacturer regularly engaged in production of such equipment.

.9 Fans shall conform to AMCA bulletins regarding testing and construction. (Airfoil fans shall bear the AMCA certified rating seal for airflow and sound).

.10 Coils shall be ARI certified.

.11 Filter media shall be ULC listed.

.12 Unit shall be factory CSA approved.

.13 After construction, units shall be cleaned thoroughly before shipping. All floor surfaces and wall surfaces shall be thoroughly degreased and cleaned. After cleaning, units shall be shrink wrapped using a heavy gauge heat shrinkable plastic wrap.

.14 During storage, contractor shall store units in a dry heated environment. Fan wheels shall be rotated monthly during storage. Units shall be regularly inspected for moisture and any job site moisture shall be immediately removed.

1.5 COMMISSIONING

.1 The manufacturer and/or their factory representative will participate in the commissioning process. The manufacturer will inspect the final installation and verify that the product has been installed as per the manufacturer's instructions. The manufacturer will report compliance or discrepancies directly to the Consultant.

PART 2 - PRODUCTS

2.1 DESCRIPTION

.1 Provide factory assembled air handling unit in configuration as indicated on drawings. Unit shall include all specified components installed at the factory. Field fabrication of units and their components will not be accepted.

.2 The unit shall be designed to be supported by a house keeping pad.

2.2 ACOUSTICAL PERFORMANCE

.1 The casing shall have been tested for acoustical performance by an independent laboratory that is accredited. Manufacturers shall submit sound data in compliance with the following:

.2 Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73.

.3 Sound Transmission Loss DB ASTM E-90 & E413-73

	1	2	3	4	5	6	7	8	
2” wall	18	19	27	33	43	52	52	52	STC=37

.4 Test methods and facilities used to establish sound absorption values shall conform explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption Coefficients by the Reverberation Method: ASTM C423-84A and E795-83.

Sound Absorption ASTM C423-84A & E795-83

	1	2	3	4	5	6	7	8	
2” wall	.10	.23	.75	1.08	1.05	.99	.97	.95	STC=37

2.3 CASING

.1 Walls and roofs shall be constructed of satin coated 16 gauge galvanized steel, G90, with minimum 100mm thick double walled insulated construction. The inner liner shall be 22 gauge solid galvanized steel galvanized steel. Insulation shall be 4.0 lb. density mineral fiber.

.2 All permanently joined flanged panel surfaces shall be sealed with an individual strip of 1/8" X 3/8" tape sealer. Wall and roof seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.

.3 Cabinet shall be pressures tested.

2.4 INSULATION

.1 All insulation used in air handling unit walls, roof and base shall have a Flame spread rating of less than 25 and a Smoke Developed rating of less than 50 per ASTM E84 and UL 723 and Can/ULC S102-M88.

.2 Insulation shall meet NFPA 90A and 90B.

2.5 STRUCTURAL BASE CONSTRUCTION

.1 Units shall be constructed from a minimum C6x8.2 lb./sq.ft. channel structural steel perimeter base, with 2x2x1/4 intermediate structural steel channel and angle iron supports. Perimeter structural steel base shall be designed to directly support the weight of the walls. Intermediate structural steel and angle iron shall support the weight of all internal components (i.e. fans, coils, etc.). Maximum base deflection shall be ¼ inch on unsupported spans of 12 ft. Structural steel base shall be designed so that it can be point loaded or set on an unlevel surface and shimmed by the contractor within 12 foot spans without deflecting more than ¼ inch. The structural steel base shall be either I-beam construction or C-channel (not box channel) so that the base will shed all water. Base shall be provided with lifting lugs, minimum four (4) per shipping split. Formed metal bases formed from sheet metal will not be acceptable. Base shall prevent wall panel joints from separating during lifting, transportation and rigging.

.2 Lifting lugs shall be located and engineered to properly support the loads within. Manufacturers shall provide a load point calculation along with detailed lifting lug information as part of the shop drawing package.

.3 A 0.12” thick aluminum checker plate floor shall be installed on the base. Floor seams shall be continuously welded providing a completely flat unit floor. Standing seems will not be accepted in any section. Steel checker plate floor shall be coated with grey epoxy paint. A 1-1/2" perimeter collar shall be provided to ensure the unit is internally watertight. The collar shall be alternately screwed down and tack welded to the unit base on one (1) foot centres. Caulk joint to be watertight.

.4 The base shall be insulated with 100mm thick, 1-1/2 lb. density fibreglass insulation and sheeted with a 22 gauge galvanized steel liner. The base liner shall be broken, tack welded and sealed for rigidity and vapour barrier integrity.

2.6 ACCESS DOORS

.1 Access door construction and width shall match the rest of the unit casing. Corners shall be welded for rigidity. Spot welding of corner seems will not be accepted. 4.0 lb. density insulation shall be sandwiched between the outer and inner skins. A 10" x 10” (double pane) tempered glass window shall be provided in each door.

.2 Provide two chrome plated high pressure latches operable from either side of the door. Hinges shall be continuous piano type stainless steel. Door openings shall be fully gasketed with continuous 1/2" closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door opening perimeter. Door frames shall be framed from 16 gauge galvanized steel with the outside of the door flush to the unit. Minimum door width shall be as shown on the plans but in no case shall an access door be less than 18". Door height shall be the maximum permitted by the height of the unit up to 72".

.3 Doors shall open against positive pressure.

2.7 FANS

.1 All fans shall be tested in accordance with AMCA Standards 210-70 and 310 Test Codes for Air Moving Devices. Backward inclined fans shall bear the AMCA sticker for both air and sound performance.

.2 Fan Wheels and Shafts: Provide air foil blades on all fans wheels. Provide solid shafts keyed to the fan wheel. Coat fan shaft with rust inhibitor. Hollow shafts will not be acceptable.

.3 Fan bearings shall be self aligning pillow block, grease lubricated, extra heavy duty anti-friction ball or spherical roller type selected for an L10 life of 200,000 hours at design operating conditions. Bearings are to be mounted on the integral fan scroll bracing.

.4 Fan and motor shall be mounted on an all welded, structural steel, prime coated and internal isolation base. The outlet of the fan shall be separated from the unit casing by means of a factory installed flexible connection. The internally mounted motor shall be provided on a slide rail base to allow proper adjustment of belt tension.

.5 Provide an OSHA approved fully enclosed metal belt guard having side of galvanized steel and expanded metal face. Belt guard shall be sized to allow either sheave to be increased by two sizes.

.6 Provide fixed pitch sheaves rated at 150% of motor nameplate H.P. Allow for one (1) drive change for air balancing purposes (parts only, labour by air balancer).

.7 On air handling units with ABB variable speed drives, mount the VSD on the unit. Factory wire between the VSD and fan motors. Ensure all casing penetrations are sealed to be air tight. Provide a terminal block within the VSD for field termination of line side wiring.

2.8 MOTORS

.1 Motors shall be designed for severe duty in accordance with IEEE 841 standards and shall meet NEMA MG1 Part 31. Motors shall be operable at 600 Volts, 60 Hz, 3-phase.

.2 Motor enclosure shall be totally enclosed fan cooled and rated to IP55. A non metallic cooling fan shall be provided. Frame, end bells and fan cowl shall be manufactured of heavy duty cast iron. The end plates shall be sealed to the frame joints. Enclosure shall be epoxy coated and rated for ASTM B117-90 96 hour salt spray test.

.3 Motor windings shall have class F insulation with class B temperature rise ratings. Windings shall be 200C inverter spike resistant wire. Motor windings shall withstand 2000V transients. Motor service factor shall be 1.15 on sine wave power and 1.0 on VFD power.

.4 Bearings shall be regreasable without disassembly and provide for the elimination of purged grease. Bearing life shall be a minimum of L10 at 50000 hours. Bearing seals shall be Inpro or equivalent.

.5 Motors shall be balanced to less than 0.08 inches per second (filter out) and the vibration test data shall be shipped with the motor.

.6 Nameplates shall be stainless steel and contain both NEMA data and bearing data.

.7 Motors used with variable frequency drives shall be provided with a brush system to electrically ground the shaft and discharge any induced voltage on the motor shaft, with a direct path to ground.

.8 Motor shall be provided with a 3 year warranty.

.9 Acceptable motor manufacturers are Reliance-Baldor, US Motors, and TECO-Westinghouse.

2.9 VIBRATION ISOLATION

.1 An integral all weld steel vibration isolation base shall be provided for the fan and motor.

.2 Provide open spring mounts with iso stiff springs, sound deadening pads and leveling bolts.

.3 Horizontal stiffness shall be equal to vertical stiffness.

.4 Spring deflection shall be 2".

.5 Isolators shall have earthquake restraints. Upon request, the unit manufacturer shall submit a restraint detail certified by a professional engineer.

2.10 HEATING AND COOLING COILS

.1 Coils shall be fully enclosed within casing and mounted on angle frames manufactured to allow coils to be individually removed. Cooling coil racks and coil casings shall be 12 Ga. 304 stainless steel. Heating coils shall be mounted on galvanized angle racks. Coils shall be bottom drainage and be provided with an air-blowout connection. Means shall also be provided to continually circulate supply air from the unit through the coil.

.2 Removable coil access panels shall be provided to remove coils through casing wall. Coil covers shall be double wall construction with all exposed edges of insulation covered with sheet metal including holes through the cover for coil header stub outs. Coils shall be individually removable towards the access side.

.3 All drain pans shall be double wall continuously welded 304 stainless steel. Intermediate drain pans shall be interconnected with stainless steel 1" down pipes. Condensate drain shall be a minimum 1-1/4" diameter stainless steel tube extending 1" out from unit for solder connection to trap. Drain pans shall be sloped within unit and fully drainable.

.4 Coils shall be certified in accordance with ARI Standard 410.

.5 Cooling coils shall be supplied with moisture eliminators in the leaving air side of the coils to collect any water carryover. Eliminators shall be 304 SS construction and drain all collected moisture into drain pan.

.6 Construction:

- .1 Tubes: Horizontal, copper 0.035” tube thickness.
- .2 Fins: Aluminum mechanically bonded to tubes.
- .3 Headers: Seamless copper with vent and drain connections.
- .4 Casing: 16 gauge, galvanized steel for heating and stainless steel for cooling, channels with 16 gauge center and end supports.
- .5 Connections: Svame end, counterflow, with vent, drain, supply and return stubs extended to outside of unit casing with grommets for airtight casing. Roof mounted units shall have the centre of the bottom coil connections located 10” off the unit floor.

2.11 PREFILTERS

.1 Prefilters shall be (2"-50mm) AM-AIR 300, medium efficiency (at least 35%), pleated, disposable type, MERV 8. The filter shall be listed by Underwriters Laboratories as Class 2.

.2 Prefilters shall be installed in a prefabricated channel rack.

.3 Prefilters shall be lift out from upstream access section.

2.12 FINAL FILTERS

.1 Final filters shall be high performance, AAF deep pleated 12" long cartridge disposable type, MERV 14. Each filter shall consist of glass fibre media, media support grid, contour stabilizer and enclosing frame.

.2 Final filter media shall be of high density microfine glass fibers laminated to a non-woven synthetic backing to form a lofted filter blanket. The filter media shall have an average efficiency of 95% on the ASHRAE Test Standard 52. The filter shall be listed by Underwriters Laboratories as Class 2.

.3 Holding frames shall be factory fabricated of 16 gauge galvanized steel and shall be equipped with gaskets and 2 heavy duty positive sealing fasteners. Each fastener shall be capable of withstanding 25 lb. pressure without deflection. They will be capable of being attached or removed without the use of tools.

.4 Final filters shall be lift out from upstream access section.

2.13 DRAINS

.1 Provide 1 1/4" capped floor drain connections on the side of the unit for complete drainability of the base pan for the following sections:

- .1 Fresh Air Plenums
- .2 Humidifier Sections
- .3 Service Corridors
- .4 Fan Sections
- .5 Sections upstream and downstream of coils
- .6 All sections if unit has washdown liner

.2 Depth of trap for drains shall be equal to total static pressure of the unit + 50%.

2.14 LIGHTS

.1 Four (4) foot long, vapour proof fluorescent ceiling mounted marine lights with wall mounted duplex receptacles shall be provided in each access section. One (1) switch with an indicator light shall be installed on the exterior of the unit. Factory wire from switch to all lights in EMT conduit with liquid tight connections. Electrical power shall be 120V/1/60.

2.15 FILTER GAUGES

.1 Provide electronic filter gauges which have a digital display and a 4-20mA or 0-10VDC signal to indicate air pressure drop. Power the gauges from the lighting circuit.

.2 Magnehelic gauges shall be accurate to +/- 2% of full range.

.3 Provide sensing probes and shut off valves for each gauge.

.4 Provide one gauge flush mounted into the casing for each filter bank.

2.16 ALUMINUM AIRFOIL DAMPERS

.1 Aluminum airfoil frames and blades shall be a minimum of 12 gauge extruded aluminum. Blades to be 6" wide single air foil design.

.2 Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames 2" x 4" x 5/8" on linkage side, 1" x 4" x 1" on the other sides.

.3 Pivot rods shall be 7/16" hexagon extruded aluminum interlocking into blade section. Bearings to be double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.

.4 Bearing shall be designed so that there are no metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.

.5 Blade linkage hardware is to be installed in frame out of airstream. All hardware to be on non-corrosive reinforced material or cadmium plated steel.

.6 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

.7 Outdoor air dampers shall be Internal hollows shall be insulated with 7/8" thick polyurethane foam with R factor of 5.0 per inch. Blades shall be 100% thermally broken. Frame shall be insulated with polystyrene, R factor of 5.0 per inch.

.8 Damper blades shall be maximum 40" long per section.

.9 Dampers greater than 2 sections wide shall be provided with a jackshaft.

.10 Acceptable dampers are: T.A. Morrison "TAMCO series 1000 and 9000" and "RUSKIN

2.17 TEST PORTS

.1 Provide 1” diameter test ports for unit air stream testing in each plenum section between each component within the AHU. Test ports shall have a tube that extends between the inside and outside of the unit and a screwed cap on the exterior to allow access. The test ports shall have been flanged on the exterior to allow air seal and shall be flanged on the interior to cover the penetration of the casing

2.18 ELECTRICAL

.1 Factory wire and test all air handling units. Have units approved by CSA or ETLc.

.2 Supply one @ 600 V/60 Hz/3 Ph power connection for motors and other large electrical devices and one @ 120 V/208V/60 Hz/1 Ph power connection for lights, controls, heaters, etc.

.3 A bonding wire shall be provided between the motor loads and the electrical panel. Use of the air handling unit casing for a bond will not be accepted.

.4 Label and number code all wiring and electrical devices in accordance with the unit electrical diagram. Mount the devices in a control panel inside the unit's service enclosure or on the outside. Ensure the control panel meets the CSA or Canadian Electrical Code (CEC) standard for the specific installation.

.5 Provide a system of motor control including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, auxiliary contactors and terminals for the connection of external control devices or relays. Individually fuse all fan and branch circuits.

.6 Wire from the motors to the motor control in accordance with the local electrical code and contained by EMT conduit with liquid tight connections. Seal the casing penetrations in a manner that eliminates air leaks. At all split sections, provide a 1 foot long piece of flexible conduit, with the extra wire spooled, for reconnection on site by the installing contractor.

2.19 FINISH

.1 Unit shall be finished painted with two components, each bond primer and finish painted with alkyd enamel, colour as selected by Owner. All uncoated steel shall be painted with grey enamel. All metal surfaces shall be prepainted with vinyl wash primer to ensure paint bonds to metal.

2.20 AIR LEAKAGE TESTING

.1 Unit manufacturer shall factory pressure test each air handling unit to ensure the leakage rate of the casing does not exceed 1.0% of the unit air flow at 1.5 times the rated static pressure. Leakage test shall be performed with VFD panels installed.

.2 Test shall be conducted in accordance with SMACNA duct construction manual. A calibrated orifice shall be used to measure leakage airflow.

.3 An officer of the air handling unit company shall certify test results. Forward copies of certified test results to the consultant. The consultant and owner shall witness the pressure test on the first two units. Provide for all transportation for the consultant and owner to the factory.

2.21 FLOOD TESTING

.1 All unit bases shall be flooded to a level of 1.25" after manufacturing to assure no leakage through the floor and the perimeter water barrier. The results of the flood test shall be certified by the manufacturer.

2.22 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 JLR Specified Products and bases of design:

.1 Air Handling Units Haakon

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air handling equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install units on a flat surface level within 1/8 inch and of sufficient strength to support the units.

.2 Provide components furnished as per manufacturer's literature.

.3 Provide all water piping so water circuits are serviceable, without having to dismantle excessive lengths of pipe.

.4 Provide valves in water piping upstream and downstream of each coil for isolating the coils for maintenance and to balance and trim the system.

.5 Provide drain valves and vent cocks to each coil.

.6 Provide strainers ahead of all pumps and automatic modulating valves.

.7 Provide certified wiring schematics to the electrical division for the equipment and controls.

.8 Provide all necessary control wiring as recommended by the manufacturer.

.9 Provide condensate traps in accordance with manufacturers recommendations.

.10 Insulate all piping and equipment mounted inside the corridor.

.11 Provide sheaves and belts required for final air balance.

.12 Install flexible connections at fan inlets and outlets

.1 Ensure metal bands of connectors are parallel and no touching.

.2 Ensure that fan outlet and duct are aligned when can is running.

.13 Install P trap on drain lines.

.1 Depth of water seal to 1.5 minimum times static pressure at this point.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section describes the minimum performance and build quality of Fan Coil Units.

1.2 REFERENCES

.1 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)

.1 ANSI/ASHRAE/IES 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 National Fire Protection Association (NFPA)

.1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.

.3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:

.1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.

.2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.

.4 Product data will include all relevant information to confirm the specifications have been met.

.5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.

.6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.

.7 Product data will include any relevant information which Division 25 requires for a properly functioning building automation system.

.8 Product data will include information as specified in 20 01 01 Common Work Results – Mechanical unless modified with additional information required below.

.9 Product data to include:

.1 Filters, fan accessibility.

.2 Anchoring of cabinet.

.3 Thermostat, transformer, controls where integral.

.4 kW rating, voltage, phase.

.5 Cabinet material thicknesses.

.6 Unit assembly instructions.

.7 Unit dimensions.

.8 Required clearances.

.3 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.

.2 Maintenance data will include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer's maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.4 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 MAINTENANCE REQUIREMENTS

.1 Contractor will verify and demonstrate that proper maintenance can be performed on equipment and material installed.

.2 Contractor will supply the following materials to site just prior to substantial being awarded:

.1 Provide one set of V belts for each belt drive fan.

1.5 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment will bear a CSA label or have an ESA certification.

.3 Air moving equipment will bear an AMCA label.

.4 Where applicable equipment will bear a ULC or UL label.

.5 All fans prior to shipment will be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel will be statically and dynamically balanced. Fans balance readings maintained and a written copy will be available upon request.

1.6 COMMISSIONING

.1 The manufacturer and/or their factory representative will participate in the commissioning process. The manufacturer will inspect the final installation and verify that the product has been installed as per the manufacturer's instructions. The manufacturer will report compliance or discrepancies directly to the Consultant.

PART 2 - PRODUCTS

2.1 FAN COIL UNITS

.1 Cabinet: steel, internally insulated with 1" thick 1.5 lb. /ft3 dual density fiberglass, baked enamel coat finish, in-ceiling mounted, inlet/outlet as indicated on drawings and access panel for ease of maintenance.

.2 Return Plenum: Complete with filter frame and filter, fabricated of 18 gauge galvanized steel, insulated with 1/2" matt-faced fiberglass insulation

- .1 Insulation conforms to:
  - .1 ASTM C1071 (including C665).
  - .2 UL 181 for erosion.
  - .3 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and NFPA 90A.

.3 Cooling Coil: performance as indicated, seamless copper tubes with intruded tube holes, copper sweat connection, and vent and drain connections. Stainless steel drain pan positively sloped and insulated. Coils to be leak tested and furnish AHRI labels and certifications.

.4 Heating Coil (if specified on drawings): performance as indicated, seamless copper tubes with intruded tube holes, copper sweat connection, and vent and drain connections. Coils to be leak tested and furnish AHRI labels and certifications.

.5 Fans: DWDI forward curved, statically and dynamically balanced, removable for maintenance, ECM blower motor.

.6 Controls:

- .1 Unit shall be supplied with a DDC interface board.
- .2 DDC Interface board shall have three 24-volt relays with line-voltage contactors to operate the fan motor speeds.
- .3 DDC interface board shall have terminal connections for interfacing to:
  - .1 Wall-Mounted Thermostat.
  - .2 Low-voltage, on-off valve actuators.
  - .3 A return air sensor.
  - .4 A pipe temperature sensor for changeover from heating to cooling on two-pipe systems.
  - .5 Condensate overflow switch.
  - .6 Room occupancy sensor.

.7 Capacity: as indicated on drawings.

2.2 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Fan Coil Units Daiken, IEC, Nailor, EH Price

.2 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of ductwork.

.3 Locate controls, dampers and access panels for easy access.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section describes the minimum performance and build quality of cabinet convector heaters.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA C22.2 No.46-M1988 (R2001), Electric Air-Heaters.

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

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data shall include all relevant information to confirm the specifications have been met.
- .5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
- .7 Product data shall include any relevant information that Division 25 requires for a properly functioning building automation system.
- .8 Product data shall include information as specified in 20 01 01 Common Work Results – Mechanical unless modified with additional information required below.
- .9 Additional information required.

.3 Provide shop drawings in accordance with Section 01 33 01 – Submittals. Indicate:
- .1 Product characteristics.
- .2 Performance criteria.
- .3 Mounting methods.
- .4 Physical size.
- .5 kW rating, voltage, phase.
- .6 Cabinet material thicknesses.
- .7 Limitations.
- .8 Colour and finish.

.4 Maintenance Data:

.1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 00 – Closeout Procedures.

.2 Maintenance data shall include but not be limited to:

.1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.

.2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.

.3 The manufacturer's maintenance and installation data.

.4 Safety informational data for maintenance staff prior to performing maintenance requirements.

.5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.

.6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.5 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Perform a review of existing conditions to ensure cabinet unit heater will fit into existing void. Contractor is responsible for any revisions to the existing conditions to install cabinet unit heater.

PART 2 - PRODUCTS

2.1 FORCE FLOW UNITS

.1 Provide recessed mounted force flow unit of rating and capacity as indicated on drawings.

.2 Cabinet: heavy duty corrosion resistant steel with removable front panel to provide inhibited access to internal structure for servicing the motor, fans, controls and coils. Glass fiber insulation, collars for recessed installation and integral air outlet and inlet grille. Maximum depth 242 mm, adjustable bezel full perimeter allowing recess from 25 mm to 230 mm.

.3 All components including enclosures, covers, grilles, hangers, brackets, access doors, end caps, corners, trim strips, and pilaster covers to be cleaned, phosphatized and finished with a baked grey enamel primer. Perform touch-up of prime finish on site. Spot weld prior to painting.

.4 Coils: evenly spaced aluminum fins mechanically bonded to copper tubes. Water coils suitable for 1035 kPa rated at 18°C standard entering air, 49°C maximum leaving air temperature, 93°C entering water temperature, 11°C temperature drop.

.5 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven on sleeve bearings, resilient mounted, corrosion resistant.

.6 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.7 Provide integral control system incorporating heavy duty switch with integral thermal overload: electric thermostat with speed control, all rated at 120/1/60 and as indicated on drawings and schedule.

2.2 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Cabinet Convector Units: Sigma, Rittling

.2 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 INSTALLATION

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

.2 Install wall mounted thermostats in locations indicated.

.3 Make power and control connections.

3.2 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by cabinet convector heater installation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section describes the minimum performance and build quality of finned tube radiation heaters.

1.2 REFERENCES

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

.2 Hydronic Institute of Boiler and Radiator Manufacturers (IBR).

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
  .1 Product data will be submitted for all PART 2 – PRODUCTS specified herein.
  .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
  .3 Product data will include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
  .4 Product data will include all relevant information to confirm the specifications have been met.
  .5 Product data will provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment not supplied, which are operating at their upper and lower limits for their design duty performance.
  .6 Product data will identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
  .7 Product data will include any relevant information that Division 25 requires for a properly functioning building automation system.
  .8 Product data will include information as specified in 20 01 01 – Common Work Results – Mechanical unless modified with additional information required below.
  .9 Additional information required.

.3 Provide shop drawings in accordance with Section 01 33 01 – Submittals. Indicate:
  .1 Equipment, capacity, piping, and connections.
  .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.
  .3 Special enclosures.

.4 Maintenance Data:
  .1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.

.2 Maintenance data will include but not be limited to:
- .1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.
- .2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.
- .3 The manufacturer's maintenance and installation data.
- .4 Safety informational data for maintenance staff prior to performing maintenance requirements.
- .5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.
- .6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.5 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

PART 2 - PRODUCTS

2.1 FINNED TUBE CONVECTOR UNITS

.1 Enclosures: steel, factory baked prime coated, complete with jointed components for wall-to-wall installation. Support rigidly top and bottom, on wall-mounted brackets. Backplate: galvanized, full length.

.2 Spot weld prior to painting. Clean, phosphatize and finish with a baked grey enamel primer: all components including enclosures, covers, grilles, hangers, brackets, access doors, end caps, corners, trim strips and pilaster covers.

.3 Provide cabinets that do not run wall-to-wall with end caps. End caps that are exposed to view not to have knockouts or cutouts.

.4 Heating element: seamless copper tubing, mechanically expanded into flanged collars of evenly spaced aluminum fins 100 mm x 100 mm nominal, 162 fins per metre, suitable for solder fittings.

.5 Element hangers: quiet operating, plastic-lined cradle type, unrestricted longitudinal movement on enclosure brackets, on 1 m cc maximum.

2.2 PERFORMANCE

.1 Sizes, capacities and arrangements indicated on drawings.

2.3 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Finned Tube Convector Units: Sigma, Rittling

.2 JLR Specified Products and bases of design: Nil

PART 3 - EXECUTION

3.1 INSTALLATION

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

.2 Install in accordance with piping layout and reviewed shop drawings.

.3 Provide for pipe movement during normal operation.

.4 Maintain sufficient clearance to permit service maintenance.

.5 Valves:

.1 Install valves with stems upright or horizontal unless approved otherwise.

.2 Install isolating gate valves on inlet and lockshield globe balancing valves on outlet of each unit.

.6 Venting:

.1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.

.2 Install standard air vent with cock on continuous finned tube radiation.

.7 Clean finned tubes and comb straight.

.8 Install flexible expansion compensators as indicated.

3.2 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by radiation heater installation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section describes the minimum performance and build quality of unit heaters.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA C22.2 No.46-M1988 (R2001), Electric Air-Heaters.

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

.3 ASTM International
- .1 ASTM E 84-11a, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .2 ASTM C916-1985(R2007), Standard Specification for Adhesives for Duct Thermal Insulation.
- .3 ASTM C 1071-05e1, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.4 National Fire Protection Association (NFPA)
- .1 NFPA 90A-2012, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

.5 Underwriters' Laboratories (UL) Inc.
- .1 UL 2021-1997, Fixed and Location-Dedicated Electric Room Heaters.

1.3 INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 01 – Submittals.

.2 Product Data:
- .1 Product data shall be submitted for all PART 2 – PRODUCTS specified herein.
- .2 Provide manufacturer's printed product literature and datasheets for material specified, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Product data shall include all maintenance access points and dimensional clearances, such that the contractor cam properly layout the equipment to ensure proper access.
- .4 Product data shall include all relevant information to confirm the specifications have been met.
- .5 Product data shall provide all relevant data and operational points that verify the engineered criteria have been met and that field operational tolerances can be accommodated, i.e., equipment are not supplied, which are operating at their upper and lower limits for their design duty performance.
- .6 Product data shall identify all ancillary field installed devices and provide all information required for the coordination of the installation with other trades.
- .7 Product data shall include any relevant information which Division 25 requires for a properly functioning building automation system.
- .8 Product data shall include information as specified in 20 01 01 – Common Work Results – Mechanical unless modified with additional information required below.
- .9 Additional information required.

.3 Provide shop drawings in accordance with Section 01 33 01 – Submittals. Indicate:
- .1 Product characteristics.
- .2 Performance criteria.
- .3 Mounting methods.
- .4 Physical size.
- .5 kW rating, voltage, phase.
- .6 Cabinet material thicknesses.
- .7 Limitations.
- .8 Colour and finish.

.4 Maintenance Data:
- .1 Provide maintenance data including certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties, for incorporation into manuals specified in Section 01 77 01 – Closeout Procedures.
- .2 Maintenance data shall include but not be limited to:
  - .1 Certificates, signed by the manufacturer or their representative, certifying that the materials have been installed as per their installation instructions.
  - .2 The approved shop drawings with performance criteria, edited with field observations and commissioned operational set points and adjustments.
  - .3 The manufacturer's maintenance and installation data.
  - .4 Safety informational data for maintenance staff prior to performing maintenance requirements.
  - .5 List of all routine maintenance requirements as well as monthly, annual or other periodical maintenance recommendations from the manufacturer.
  - .6 Any maintenance requirements that may affect the warranty periods of the associated equipment.

.5 Provide copies WHMIS MSDS - Material Safety Data Sheets in accordance with Division 1 where material specified has MSDS Sheets.

1.4 QUALITY ASSURANCE

.1 Performance Requirements Defined: catalogued or published ratings for manufactured items obtained from tests carried out by manufacturer or those ordered by manufacturer from an independent testing agency signifying adherence to codes and standard and standardized testing of performance criteria.

.2 Electrical equipment shall bear a CSA label or have an ESA certification.

.3 Air moving equipment shall bear an AMCA label.

.4 Where applicable equipment shall bear a ULC or UL label.

.5 All fans prior to shipment shall be completely assembled and test run as a unit at operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced. Fans Balance readings maintained and a written copy shall be available upon request.

PART 2 - PRODUCTS

2.1 UNIT HEATER - HYDRONIC

.1 Provide unit heaters of rating and capacity as indicated on drawings. Outlet to have integral double folded discharge frame. Inlets to have integral inlet collars for superior rigidity.

.2 Cabinet: heavy duty cold rolled and corrosion resistant steel with rounded exposed corners and edges. Suspension tappings securely fastened to top panel.

.3 All components including enclosures, covers, grilles, hangers, brackets, access doors, end caps, corners, trim strips, and pilaster covers to be cleaned, phosphatized and finished with a baked grey enamel primer. Perform touch-up of prime finish on site. Spot weld prior to painting.

.4 Coils: evenly spaced aluminum fins mechanically bonded to copper tubes. Copper tubes to be heavy wall 5/8" outside diameter copper tube. Water coils pressure tested to 350 PSIG suitable for 1035 kPa rated at 18°C standard entering air, 49°C maximum leaving air temperature, 93°C entering water temperature, 11°C temperature drop. Coils suitable to steam applications up to 100 PSIG

.5 Fans: propeller fan, statically and dynamically balanced, direct driven on sleeve bearings, resilient mounted, complete with fan guard.

.6 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.7 Diffuser: Horizontal louvres with individually adjustable blades for maximum air distribution adaptability.

.8 Provide integral control system incorporating heavy duty switch with integral thermal overload: electric thermostat with speed control, all rated at 120/1/60.

2.2 JLR AND OWNER SPECIFIED PRODUCTS

.1 Refer to Division 00 and 01 for requirements for alternate manufacturer's to those listed below:

.2 The following are Owner acceptable manufacturers, all others will be rejected unless pre-approved during tender:

.1 Unit Heaters: Sigma, Rittling

.3 JLR Specified Products and bases of design:

.1 Nil

PART 3 - EXECUTION

3.1 INSTALLATION

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

.2 Installation type, height and clearances shall be as per manufacture’s installation instructions and recommendations.

.3 Install wall mounted thermostats in locations indicated.

.4 Include double swing pipe joints as indicated.

.5 Check final location with Consultant if different from that indicated prior to installation.
.1 Should deviations beyond allowable clearances arise, request and Consultant's directive.

.6 Hot water units: for each unit, install ball valve on inlet and balancing valve on outlet of each unit. Install drain valve at low point.
.1 Install manual air vent at high point.

.7 Clean finned tubes and comb straight.

.8 Provide supplementary suspension steel as required.

.9 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.2 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by unit heaters installation.

END OF SECTION

PART 1 - GENERAL

1.1 DIVISION 25 BASE BID CONTRACTOR

.1 The Owner, University of Guelph, maintains numerous buildings, which are controlled by a common Energy Management and Control System.

.2 The Division 25 contractor shall be: **Siemens Canada Limited**

.3 The base bid contractor shall insure that the system install meets or exceeds the requirements of the owners design standard, Design Standards DSM-03, Building Automation Systems.

.4 The base bid contractor shall provide a system, which provides connectivity with the campus wide EMCS system. The installed system shall utilize the latest current technology and software that provides that connectivity.

1.2 WARRANTY AND MAINTENANCE

.1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components described in Submittal article.

.2 Emergency Service Calls: Initiate service calls when EMCS is not functioning correctly. Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost. Furnish Owner with telephone number where service personnel may be reached at any time. Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.

.3 Perform Work continuously until EMCS restored to reliable operating condition.

.4 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.5 No system modification, including operating parameters and control settings, to be made without prior written approval of Owners technical representative.

1.3 DOCUMENTS

.1 The contact documents are complementary, what is required by any one shall be as binding as if required by all. Specification sections and drawings cannot be read in isolation and it shall be the responsibility of the contractor and suppliers to ensure they have sufficient information to provide specified material and services as required by the complete contract documents

.2 These specifications are an integral part of the Contract Documents. Refer to other Sections to ensure a completed operational product and fully coordinated standard of work.

.3 Definitions:
- .1 "Provide" means to "supply and install".
- .2 "Concealed" means within chase, furred space, shaft, or hung ceiling.
- .3 "Exposed" means "not concealed" as defined herein.
- .4 “Demolish” means to “remove from site and depose of in an appropriate manner”.

.4 Conform to Canadian Metric Practice Guide CSA CAN3- 234.1.

.5 Provide all required adapters between "metric" and "Imperial" installations.

.6 Metric descriptions in this Division are nominal equivalents of Imperial values.

.7 “NPS” refers to Nominal Pipe Size and is the ASME B36 designation for various standard pipe sizes.

.8 Drawings do not indicate exact architectural, structural or electrical features. Examine drawings prior to fabricating and installing work to ensure no interference exists. Report conflict with work to Consultant before proceeding.

.9 Drawings show general design and arrangement of mechanical system installation, and are diagrammatic in some details. Coordinate all drawings and with all trades for complete operational system.

.10 Do not scale drawings to order material. Take field measurements before ordering materials and make material conform to site conditions.

1.4 OWNERS DESIGN STANDARD DSM-03

.1 The Owner, University of Guelph, maintains a design standard identified as:
University of Guelph
Physical Resources, Design engineering and Construction
Design Standards DSM-03
Building Automation Systems

.2 This standard is appended to this specification and takes precedence over all documentation presented on the drawings or specifications.

.3 The Division 25 contractor shall make themselves aware of the conditions and requirements of this standard and install a system that meets this standard.

1.5 COOPERATION WITH OTHER TRADES

.1 Review all contract documents, including those of the other trades, and coordinate with work of other Divisions and trades.

.2 Cooperate fully with Divisions 21, 22, 23, 25 and Division’s 26 and 27 prior to installation to lay out location of ducts, diffusers, piping, lighting fixtures and other mechanical and electrical components in all areas.

.3 Report areas of conflict immediately to Consultant for comment. Do not continue work until corrective measures are prescribed.

.4 Locate distribution systems, access doors, equipment and materials for maximum useable space to satisfaction of Consultant.

1.6 CONTRACTOR COORDINATION SUBMITTALS

.1 This Contractor shall assist and review the Interference and Coordination drawings for spaces identified in 20 01 01 - Common Work Results For Mechanical.

1.7 CONTRACTOR REQUESTS FOR INFORMATION

.1 The Contractor may, after exercising due diligence to locate required information, request from the Consultant clarification or interpretation of the requirements of the Contract Documents. The Consultant shall, with reasonable promptness, respond to the Contractor's requests for clarification or interpretation.

However, if the information requested by the Contractor is apparent from field observations, is contained in the Contract Documents or is reasonably inferable from them, the Contractor shall be responsible to the Client for all reasonable costs charged by the Consultant to the Client for the additional services required to provide such information.

1.8 FIRE STOPPING

.1 Reference Section 07 84 00 – Fire stopping.

.2 All fire stopping to be performed by a single certified contractor.

.3 This contractor will coordinate the construction of all openings through fire rated assemblies with the fire stopping contractor.

1.9 COMMISSIONING

.1 Reference Section 01 91 00.02 – General Commissioning (CX) Requirements.

.2 The Contractor to make themselves, their subcontractors and their suppliers aware of the commissioning requirements for this project.

.3 The Contractor shall work with the designated commissioning agent to achieve a completely commissioned system. The contractor shall provide all material and labour to achieve the project commissioning objectives as specified.

.4 Plan, organize and implement the commissioning process for the control systems and equipment.

.5 Assist in preparation of the Commissioning Plan and schedule, identifying responsibility for activities and documentation to be provided.

.6 Deliver a system that performs in accordance with the contract documents and equipment manufacturer's requirements.

1.10 INSTRUCTION OF OPERATING STAFF

.1 Provide trained personnel to instruct operating staff in maintenance, adjustment and operation of mechanical equipment.

.2 Provide instruction during regular work hours for a minimum 2 full days prior to acceptance and turnover to operating staff.

.3 Utilize the Controls Shop Drawings and Sequence of Operation and updated record drawings for instruction purposes.

.4 Instruct staff on changes made under terms of warranty or of modifications to equipment.

1.11 IDENTIFICATION

.1 All controls components will be distinctly identified, controls wiring shall be colour coded to match U of G standards, controls cabinets shall be labeled with lamacoid labels, identifying purpose and referenced back to system architecture.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL SERVICE ACCESS DOORS

.1 Coordinate with architectural drawings for locations and wall and ceiling finishes.

.2 Size: 300 mm x 300 mm or larger, as required to properly service concealed equipment and devices.

.3 Material: 2.5 mm thick, flush type steel door, frame and anchor straps, with concealed hinge.

.4 Fire rated where penetrating fire rated assemblies.

.5 Finish: to suit painted gypsum, plaster or suspended tile ceiling.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Location of access doors to be located by responsible division. Access doors to be installed by drywall or block installer.

.2 Locate access doors to serve concealed controls equipment.

.3 Be prepared to demonstrate accessibility of devices through access doors. Relocate or enlarge access doors to suit conditions.

3.2 DEMONSTRATION

.1 Consultant and Owner’s 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.

END OF SECTION

University of Guelph
Design Standards DSM-03
Building Automation Systems

UNIVERSITY of GUELPH

PHYSICAL RESOURCES

DESIGN, ENGINEERING, AND CONSTRUCTION

DESIGN STANDARD DSM-03

BUILDING AUTOMATION SYSTEMS

Version	Revision 0
Effective Date	15-September-2014
Approved By	Manager, Mechanical Design, DEC
Reviewed By	Director, MES

TABLE OF CONTENTS

1 INTRODUCTION

1.1 General

.1 This Building Automation Systems (BAS) Design Standard has been developed to establish the University's minimum expectations and requirements for new BAS installations on campus.

.2 This Standard is based on current Codes and Standards, Industry Best Practices and the University's preferred approach to standardizing design from the perspective of system configuration and performance, operating flexibility and efficiency, maintenance practices and protocols and inventory management.

1.2 Compliance Criteria

.1 Full compliance is mandatory on projects involving new construction.

.2 Full compliance is mandatory for new BAS installation within projects involving significant renovations.

.3 Compliance is recommended to the extent practical and feasible for all projects involving minor renovations and rework of existing BAS infrastructure.

.4 Any deviations from the minimum requirements outlined in this Standard must be approved by the Manager, Mechanical Design, DEC before the completion of Schematic Design.

1.3 Responsibility of the Designer

.1 The System Designer remains responsible for ensuring any proposed design solution is in full compliance with applicable Codes & Standards in force at the time of the design.

.2 Any conflict between applicable Codes & Standards and this Standard shall be identified and presented to the Manager, Mechanical Design, DEC, together with proposed measures for addressing the conflict.

1.4 Design Innovation

.1 This Standard is not intended to preclude or constrain an Innovative Approach to Design. It however remains the responsibility of the Designer to demonstrate that any proposed design innovations are in general compliance with the design intent outlined in this Standard.

.2 All proposed Design Innovation shall be tabled for consideration by the Manager, Mechanical Design, DEC, before the completion of Schematic Design.

1.5 Reference Documents

.1 Ontario Building Code

.2 Canadian Electrical Code

.3 ASHRAE Standard ANSI/ASHRAE 135 - BACnet

.4 ASHRAE Guideline 13, Specifying Direct Digital Control Systems.

.5 ANSI/TIA/EIA862 Building Automation Systems Cabling Standard for Commercial Buildings.

.6 Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices

.7 Public Health Agency of Canada - Laboratory Biosafety Guidelines

.8 Canadian Council for Animal Care Guidelines

.9 LEED Guidelines

.10 Mechanical Plumbing Systems Standard DSM-02*

.11 Mechanical HVAC Systems Standard DSM-01*

.12 Electrical Power Systems Standard DSE-01*

.13 Architectural Space Planning & Finishes Standard DSA-01*

* A copy of these standards is available on University of Guelph Physical Resources web page

2 DESIGN STANDARDS

2.1 General

.1 The requirements outlined in the following clauses are applicable to all Building Automation System (BAS) installations. Application Specific requirements are outlined under clauses 2.2 – 2.17

.2 This document is not intended to describe the controls or sensors required for correct operation of the building systems or equipment. The Designer remains responsible for ensuring equipment and systems can be appropriately operated and maintained.

.3 Overarching Design Principles

.1 All new BAS installations shall be designed as an integrated, open protocol, BACnet compliant system to ANSI/ASHRAE Standard 135.

.2 All BAS installations in projects involving significant renovations shall be designed as an integrated, open protocol, BACnet compliant system to ANSI/ASHRAE Standard 135; any proposed deviations shall be presented to the Manager, Mechanical Design, DEC, for approval during the Schematic Design Phase.

.3 All BAS installations in projects involving minor renovations to areas currently served by Legacy (KMD) systems shall comply with 2.1.2.2 above; any proposed deviations, including modifying existing Legacy (KMD) system, shall be presented to the Manager, Mechanical Design, DEC, for approval during the Schematic Design Phase.

.4 Buildings shall not have multiple BAS systems.

.4 Interfacing Standards:

.1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EIA (Electronic Industry Association) interfaces.

.2 CSA T530: Building Facilities, Design Guidelines for Telecommunications (same as EIA/TIA 569).

.3 IEEE 802.3 Ethernet 10Base-T LAN

.5 All Components and Equipment shall be designed and selected to provide the requisite level of function and performance when operating in following minimum ambient condition ranges:

.1 Temperature: 0°to 40°C (32° to 104°F) for Indoor Installation / -30°to 40°C (-22° to 104°F) for Outdoor Installation

.2 Relative Humidity: 10% to 90% non-condensing

.3 Withstand VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes

.6 All equipment, components& devices shall be designed to operate on an electrical power service rated at 120 VAC +/- 10%, 60 Hz nominal.

.1 Components installed within Motor Control Devices to be designed to operate with transient electrical fields occurring within these devices

.7 Licences and Ownership

.1 Ownership of, and licences for, all hardware and software originally installed or required for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.

.2 Licensing to permit an unlimited number of users to access system without additional fees.

.3 As of last month of the warranty period, software is to be upgraded to current version or release at no cost to the Owner.

2.2 BAS Architecture – Individual Buildings

.1 BAS Network Architecture
  .1 Dedicated LAN for BAS:
  .2 BAS communication architecture to consist of at least two tiers with each tier using local area networks.
    .1 Tier 1: Building Controller network;
      - High level network providing communication between Building Control Unit's (BCU's) and workstations
      - Ethernet communications (ISO 8802-3/IEEE 802-3), using high speed local area network communications. TCP/IP to be used as communication protocol on first tier network.
      - Shall be designed with an expansion capacity of at least 10 additional BCU/Routers over and above those required to complete the original installation.
    .2 Tier 2: Equipment Controller network;
      - Lower level network providing communications between Equipment Control Units (ECU's) and BCU's.
      - Open, peer-to-peer control networks to interconnect BAS controllers (Building Control Units, BCU's, and/or Equipment Control Units, ECU's) on ring or star topology bus.
      - Peer-to-peer configuration means units exist and speak equally on same bus.
      - Controllers in peer-to-peer configuration can share data without assistance from Operator Interface.
  .3 System architecture to be modular, permitting stepped expansion of application software, system peripherals, and field hardware
  .4 Use of non-networked stand-alone control devices is not permitted.
.2 Control System:
  .1 High-speed, peer-to-peer network comprising microprocessor based Direct Digital Control (DDC) controllers with a web-based operator interface,
  .2 Each system controlled or monitored through the BAS, building floor plan, and control device to be displayed through point-and-click graphics,
  .3 Web server with network interface card to gather data from this system and generate web pages that can be accessed through conventional web browser on any PC connected to network,
  .4 Operators to access this system through web browser, and browser interface to perform normal operator functions.
  .5 OEM Controller integration
    .1 BAS to incorporate hardware and software to allow bi-directional data communications between BAS and 3rd party manufacturers' control panels.

2.3 BAS Functional Requirements

.1 Functional requirements shall be defined through the use of Control Sequences & Schematics and Points List used in combination.
  .1 Control sequences shall be developed based on overarching criteria defined under Clause 2.10.
.2 Controllers
  .1 Designed to operate with local closed loop programming, independent from server, if peer-to-peer communication is interrupted.
.3 Central BAS Web Server

.1 Designed to perform global application programs and data consolidation including:
  .1 communications with controllers,
  .2 host software routines for:
    - BAS Server operation,
    - Database creation and data storage,
    - Web based Graphical User Interface (GUI) with graphics generation and display,
    - Reporting

2.4 BAS Server – Individual Buildings

.1 A dedicated BAS Server is not required; rather the BAS software shall be installed on a designated Campus Server residing on a Tier I network.
  .1 Minimum performance levels for the server shall be estimated before completion of the Design Development Phase and submitted to the Manager, Mechanical Design, DEC.
  .2 Performance levels for the server shall be validated by the chosen BAS vendor and finalized within 60 days of commencement of the Construction Phase

2.5 Main Operator Workstation – Individual Buildings

.1 A dedicated Main Operator Workstation (OWS) is not required.
.2 However, each Mechanical Room / Equipment Room shall have at least one (1) designated connection point to allow access to the BAS Graphics using a portable device.

2.6 Internet Appliances

.1 BAS architecture and software to incorporate thin client design software to allow use of web appliances such as Tablets and web-enabled cellular telephones

2.7 Fibre Optic Cable

.1 Duplex 900 mm tight-buffer construction designed for intra-building environments
.3 UL listed sheath OFNP meeting requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
.4 field terminations made using ST type connectors with ceramic ferrules and metal bayonet latching bodies.

2.8 Routers and Bridges

.1 Selected as Industry standard hardware
  .1 Central system to use an Ethernet Local Area Network (LAN) for communication.
  .2 Communication between central server and controllers to be IP.
  .3 Router to bridge IP and data link (ARCNET, BACnet, MS/TP, LON) to be used between controllers if required.
  .4 Router to use FLASH memory and allow firmware updates to be performed from remote work station.

2.9 BAS Software

.1 System software to support alternate operating systems, such as Red Hat Linux, or Sun Solaris.
.2 Software to be completely web based without need for interface/translation devices or need to load software individually on each computer.
.3 System and software to permit remote access, for multiple users, through internet connections.
.4 Graphic files to be created with use of graphics generation package furnished with system.
.5 Software to support concurrent operation of multiple standard and non-standard protocols including but not limited to:

- BACnet
- MODBUS
- LONTalk
- OPC
- SNMP

.6 Operator Interface designed to operate through standard desk top or lap top personal computers without requiring purchase of special software from BAS manufacturer.
  .1 Interface on these personal computers to be standard Web Browser by Microsoft, Chrome or Firefox.

.7 System software to support automatic paging

2.10 Control Sequences - Overarching Criteria

.1 Control sequences shall be developed with consideration to the overarching criteria listed below. Where criteria have not been defined, develop control sequences based on guidelines published in the ASHRAE Handbook and/or following Industry Best Practices.

.2 Control sequence descriptions, and list of control and alarm points, shall be submitted for review/approval by the Manager, Mechanical Design, DEC and Manager, Maintenance & Energy Services prior to the completion of Design Development.

.3 Minimum Requirements
  .1 Occupied/Unoccupied mode schedule for terminal unit set-back controls
  .2 Occupied/Unoccupied mode schedule and Occupancy sensors to control AHU(s) dedicated to an individual classroom
  .3 Standalone local washroom exhaust fan interfaced with the light switch and an Off-Timer
  .4 Control Valve sequences shall incorporate a feedback loop to detect leakage past valve when in “Closed Position”
  .5 Supply Air Temperature Reset based on Terminal Unit Damper Position (for VAV Systems) and Reheat Valve Position.
  .6 Mixed Air Temperature as a means of controlling Fresh Air Damper.

.4 Fan Scheduling
  .1 Ability to set fan schedules for Summer and Winter Schedules. This schedule will be based on School terms.
  .2 Override Schedules to turn fans on or off for Holidays and special events.
  .3 Systems that can be shut down will do so based on the schedule
  .4 Systems that cannot be shut down will have their SAT setpoint offset based on the schedule.

.5 Mode Control
  .1 To prevent the various control components (valves and dampers) from competing with one another, they are operated in sequence (based on heating or cooling demand). This sequence is determined by a "mode"; various modes are described below. In each mode the PHT LL controller will always be active and will keep the heating valve from closing when the PHT is below its low limit setpoint. In each mode the MAT LL controller will be active and will close the dampers (even below the min fresh air setting) when the MAT is below its low limit setpoint.
  .2 Mode 0: Shutdown
    - Fans will stop
    - Dampers will close
    - Cooling valves will close
    - Humidity valves will close

- If outside air is colder than the MAT LL SP then the heating valve will modulate to control the MAT at the LL setpoint, otherwise the heating valve will close.

.3 Mode 1: Startup
- This mode is only necessary when it is cold outside otherwise the system will simply jump out of it and into one of the control modes.
- On 100%FA units the heating valve will fully open (on cold days) to preheat the coil before the fan starts (this is necessary since the coils may not respond fast enough when a cold PHT is detected and the unit will trip off on freezestat). Once the fan starts the heating valve will ramp down to the control point.
- On mixed air units the outside dampers will remain closed on cold days (to remove any residual heat that may have accumulated in the duct when it was off). After the morning warm-up the dampers will slowly ramp open to the control point.
- After the morning warm-up period the system will switch out of startup mode.

.4 Mode 2: Damper
- The heating coil will modulate to maintain the PHT LL setpoint.
- Cooling coil will be closed.
- Damper will modulate to maintain the SAT SP

.5 Mode 3: Heating
- Cooling coil will be closed.
- Damper will be at minimum.
- The heating valve will modulate to maintain the SAT at setpoint.

.6 Mode 4: F/B Damper or Reheat
- The damper will be at minimum position.
- The cooling coil will be closed.
- When this mode is active the heating valve will be open at least 75% and the damper will modulate the air around the coil. If the air is being all directed to the coil then the heating valve will ramp open further.

.7 Mode 5/6: Heating Stage 1 and Stage 2
- The damper will be at minimum position.
- The cooling coil will be closed.
- This mode is used for on/off heating stages (gas or electric).

.8 Mode 7: Cooling
- The damper will be at maximum (economizer/enthalpy control may close this to minimum position).
- Heating valve will be closed (PHT LL always active).
- The cooling coil will modulate to maintain the SAT at setpoint.

.9 Mode 8/9: DX Stage 1 and Stage 2
- The damper will be at maximum (economizer/enthalpy control may close this to minimum position).
- Heating valve will be closed (PHT LL always active).

.10 Mode10: Dehumidification *(*without dehumidification wheel)*
- This mode is rarely used (it requires a cooling coil before a reheat coil).
- If a temperature sensor is installed after the cooling coil then the coil will be modulated to maintain the coil discharge temperature at the dew point. If no temperature sensor is installed after the cooling coil then the coil will be 100% open.
- The reheat coil will be used to maintain the SAT at its setpoint.

.6 Mixed Air Handling Units

.1 To prevent a large inrush current draw the fans across the campus are staggered using the following formula:

*Delay time(in seconds) = (Building number) + 10 * (fan number)*

.2 Lag fans (when controlled by the automation system) will start 5 seconds after the lead fan.

.3 When the unit is off, the dampers will be closed and the heating valve will be used to maintain the MAT at its low limit setpoint (cold side of the coil). If the outside air temperature is below the MAT LL SP then a morning warmup flag will be enabled.

.4 On system startup, if the morning warmup is enabled then the dampers will remain closed during the warmup period. Once the warmup period is over the dampers will ramp open to their control point.

.5 The system will operate according to the "Mode Control" as outlined above.

.7 Fresh Air Handling Units

.1 To prevent a large inrush current draw the fans across the campus are staggered using the following formula:

*Delay time(in seconds) = (Building number) + 10 * (fan number)*

.2 Lag fans (when controlled by the automation system) will start 5 seconds after the lead fan.

.3 When the unit is off, the dampers will close automatically and the heating valve will be used to maintain the PHT at its low limit setpoint (cold side of the coil is preferable if a sensor is available). If the outside air temperature is below the MAT LL SP then a morning warmup "Heat Blast" flag will be enabled.

.4 The "Heat Blast" will just open the heating coil 100% for 2 minutes before the fan is given a start command. Once the fan is running the heating valve will ramp down to the control point.

.5 The system will operate according to the "Mode Control" as outlined above.

.8 Variable Air Volume Units (VAV's)

.1 VAV's will maintain space temperature by adjusting the volume of air into the space while keeping it between an operator adjustable minimum and maximum volume.

.2 If a reheat coil is installed then a discharge temperature sensor after the coil must be provided to identify any leaking valve.

.3 If the space temperature is below the setpoint then the VAV will switch to reheat mode in which case the volume of air will increase to a heating setpoint (minimum air volume may be too little to allow the warm air from reaching the occupants); this is typically 10% of the span between minimum and maximum and then added to the minimum.

.4 A demand limit variable is generated which can be used by the AHU to adjust the duct pressure and supply air temperature (we can't just use the space temperature and setpoint since we won't be able to determine if the VAV had more capacity to satisfy the space temperature). A value of 0% indicates the AHU should increase the supply air temperature while a value of 100% indicates that the temperature should be lowered. The AHU will only use this information if it has feedback from most of the spaces it affects.

.9 Exhaust Fans

.1 Exhaust fans will typically operate based on a predefined Occupancy Schedule.

.10 Standard Reset Schedules

.1 Air handlers will use a standard outdoor air temperature reset schedule unless there is a calculated reset from the space (typically if an AHU only feeds a few areas).

OAT	SP
30	18
20	15

10	18

.2 In the winter it may be possible to throttle (close) a heating valve to a point which causes an air handling unit to trip on a freezestat. To minimize this occurrence a minimum position for the heating valve is calculated from the outdoor air temperature.

OAT	SP
5	0
-15	20

.3 The return air humidity setpoint is also adjusted by an outdoor air temperature reset schedule.

OAT	SP
-25	15
10	40

.11 Heat Reclaim

.1 Plate heat exchanger for air to air systems will use a bypass damper when the exhaust air "ices up" and the pressure increases across the exhaust plates.

.2 "Run around" glycol loops heat reclaim systems will be disabled in the when the energy required to run the pumps is greater than the heat reclaimed (typically OAT > 10 deg C).

.12 Global Commands

.1 Chilled Water Clamp.

- ability to clamp all chilled water control valves to a fixed position (excluding critical systems)
- this will allow the chilled water valves to be limited to a maximum position for extreme hot days as well as any CUP production limitations

.2 Heating setpoint Offset

- ability to offset the setpoint for all heating systems (excluding critical systems)
- this will allow temperature setbacks for Holidays, and will limit steam requirements due to any CUP production limitations

.3 Maximum Damper Position (all Mixed Air units)

- ability to adjust maximum damper position
- this will allow maximum damper position to be limited based on outdoor temperature and humidity

.4 SAT setpoint Offset

- ability to put an offset on all fan units.
- this will allow a temperature offset to be introduced for extreme temperature days to allow for reduction of chilled water use as well as steam use

.5 Perimeter Heating Disable

- ability to disable perimeter heating for all buildings.
- this will allow buildings, on days with cool mornings and warmer days, to not use Perimeter heat in the morning and chilled water later on.

.6 VFD Maximum Clamp

- ability to limit the VFD speed for critical global adjustment days (excluding critical areas)

.7 Global Command Page
  .1 a Global Command Page shall be created on each BAS system to allow operator to monitor status of global command points and have the ability to set the values and override automatically calculated values.
  .2 this page will include:
    - Current Schedule running
    - Chilled Water Maximum clamp value
    - Heating setpoint offset value
    - Damper Maxiumum Position value
    - SAT offset value
    - Perimeter Heating enable status
    - VFD Maximum clamp value
    - Chilled water pressures and temperatures in various locations
  .3 this page is also to display the status of chilled water cooling systems that have domestic water backup

2.11 BAS Graphics

.1 At a minimum BAS graphics shall display the following:
  .1 Facility Site Graphic
  .2 Individual Graphics for each System
  .3 Terminal Unit & Equipment Floor Plan
    - Room Number and Area designation for each Terminal Unit & piece of Equipment
  .4 A Main Page in Tabular Format displaying, as applicable, the following information for each piece of equipment/system
    - Command Status
    - State Status
    - Current Setpoints
    - Current Speed
    - Current Temperatures
    - Alarm Condition, if any, displayed in a different color.
      - Alarms to be assigned a Priority Ranking and include Descriptor identifying relevant equipment and its location. (eg. E1 BLDG 040 P4 Condensate Pump failed to start <Room 008>)
    - Area served by Equipment/System with a link to the individual graphic for the said Equipment/System
.2 Graphics shall be developed using a standard library of image files and industry standard symbols.

2.12 BAS Alarms

.1 The BAS system shall be complete with all alarming required for proper operation of the equipment and systems.
.2 All time delays and alarm thresholds shall be adjustable via the software, not via the BAS graphics.
.3 Alarms shall include any specific alarms required for specialized applications.
.4 At a minimum the following alarms are to be provided:
  .1 Motor not started after commanded on
    - applies to all motors (pumps, fans, etc.)

.2 Motor not stopped after commanded off
- applies to all motors (pumps, fans, etc.)

.3 High-high level for all condensate tanks, sump pits, or any other application where a flood will occur if the high-high level is surpassed
.4 High CO_2 level (when CO_2 sensor(s) are utilized)
.5 Differential pressure across filter bank exceeds 250pa
.6 High supply humidity level in supply air duct
.7 High duct pressure
.8 High duct temperature
.9 Low plenum air temperature after 3 resets of Freezestat
.10 Temperature difference across all heating or cooling coils greater than 5°C after a 5 minute delay following control valve closing
.11 Supply air temperatures more than 5°C from setpoint for more than 10 minutes
.12 Converter temperatures more than 10°C from setpoint for more than 10 minutes

2.13 Power Supplies and Line Filtering

.1 Power Supplies:
.1 where Essential Power is available in a building, all Tier I devices shall be fed off an Essential Power source.
.2 power supplies to all BCU's and all ECU's/Control Elements associated with equipment fed off an Essential Power source shall be extended from an Essential Power source, preferably the same Essential Power source feeding the equipemt in question.
- an On-Board UPS Power source with a minimum 12 hour battery life shall be provided withing each BCU & ECU.

.3 control transformers shall be UL listed ,
.4 line voltage units shall be CSA listed,
.5 provided with over-current protection in primary and secondary circuits,
.6 sized to limit connected loads to 80% of rated capacity.
.7 equipped with

.2 DC power supplies:
.1 output to match equipment current and voltage requirements,
.2 units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes,
.3 units shall have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure,
.4 units shall be capable of operation between 0°C and 50°C (32°F and 120°F). EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

.3 Power Line Filtering:
.1 shall be provided to afford internal or external transient voltage and surge suppression for workstations and control modules,
.2 surge protection:
- dielectric strength of 1000 V minimum,
- response time of 10 nanoseconds or less,
- transverse mode noise attenuation of 65 dB or greater,
- common mode noise attenuation of 150 dB or greater at 40-100 Hz.

2.14 Automatic Control Valves

.1 Performance:

.1 General:

- Straight through water valves shall be single seated type with equal percentage flow characteristics and minimum resolution of 40:1 or greater.
- designed to close at a differential pressure of 280 kPa (40 psi), with an inlet pressure of 1035 kPa (150 psi).
- three-way mixing water valves: linear for each port giving constant total flow.
- modulating steam valves: modified linear flow characteristics.

.2 Steam Valves, Pressure Drop,.

- modulating, 100 kPa (15 psig) or less steam supply pressure: maximum 80% of inlet gauge pressure.
- two position, 100 kPa (15 psig) or less steam supply pressure: maximum 15 kPa (2 psig).
- modulating, greater than 100 kPa (15 psig) steam supply pressure: 42% of the inlet absolute pressure.

.3 Water Valves, Pressure Drop

- two position: maximum 10% of system pump head.
- modulating, two-way: maximum of 36 kPa (12 ft) pressure drop.
- modulating, three-way: maximum of 60 kPa (20 ft) pressure drop.

.2 Proportional valves - Globe:

.1 Body:

- carbon steel, bolted body.
- maximum allowable water pressure: 860 kPa (150 psi)
- maximum working temperature: 216°C (260°F).

.2 Trim:

- stem guided plug,
- V-port cage, equal percentage,
- T316 stainless steel
- threaded seat ring, T316 stainless steel.
- disc, seals, and other valve components suitable for clean water.

.3 ANSI Class IV leakage.

.3 Actuators:

.1 electric or electronic action

.2 electronic interface control board, solid state drive, reversible motor, oil immersed gear train

.3 spring return mechanism to return valve to “normal” position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),

.4 manual override for valves over NPS 2½.

.5 valve positioners:

- microprocessor based digital valve controllers,
- HART communications protocol,
- two independent adjustable travel position switches and wiring to BAS for indication of valve position.
- to be provided on automatic valves NPS 2½ and larger.

.6 general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,

2.15 Automatic Dampers

.1 Multi-leaf Dampers for general service

.1 shall be parallel blade type for two-position OPEN/CLOSED service

.2 shall be parallel blade or opposed blade type for modulating service

.3 Performance:

- leakage in closed position: maximum 2% of rated air flow at 500Pa (2 in wg) differential across assembly,
- pressure drop in open position: maximum 50 Pa (0.2 in wg) differential at 5 m/s (1000 fpm).

.4 Frame & Blade Construction :

- insulated or non-insulated depending upon service. Thermal breaks in insulated frame construction.
- extruded aluminum for general applications; formed stainless steel for corrosive environments.
- extruded aluminum, thermally broken,
- seals: extruded vinyl seals, and spring stainless steel side seals,
- maximum blade width: 125 mm (5 in),
- maximum blade length: 1200 mm (4 ft).
- self-lubricated bronze bearings.
- blade linkage with steel tie rods, brass pivots and steel brackets.

.5 Damper Actuator (Operator)

- Electric or electronic action
- electronic interface control board, solid state drive, reversible motor, oil immersed gear train
- spring return mechanism to return valve to “normal” position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),
- manual override.
- Damper positioners: microprocessor based digital damper controllers c/w
- HART communications protocol two independent adjustable travel limit switches with wiring to BAS for indication of damper position and alarm annunciation in the event position is not positively verified.
- general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,

.2 Isolation / Control Valves Type for Isolation Service:

.1 Single blade type for modulating and two position, OPEN/CLOSED, service..

.2 Performance:

- leakage in closed position: maximum 0.01% of rated air flow at 7 kPa (28 in wg) differential across assembly,
- linear characteristic with 20:1 turndown,
- sized using Cv numbers in 65% open position for pressure drop of less than 150 Pa (0.6 in wg) differential at 5 m/s (1000 fpm),

.3 Construction:

- 316L stainless steel construction for Body, Trim, Shaft and all elements exposed to the air stream
- teflon packing glands
- seat: elastomer seat compatible with paraformaldehyde and ethylene gas
- flanged gasketed connections for 7 kPa (28 in wg) service

.4 Damper Actuator (Operator)
- Electric or electronic action
- electronic interface control board, solid state drive, reversible motor, oil immersed gear train
- spring return mechanism to return valve to “normal” position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),
- manual override.
- Damper positioners: microprocessor based digital damper controllers c/w
- HART communications protocol two independent adjustable travel limit switches with wiring to BAS for indication of damper position.
- general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,

2.16 Cleanroom and Laboratory (incl. Animal Labs) Pressure Monitor

.1 Space pressure measurement, referenced to adjacent space, designed, tested, and packaged by a single manufacturer.

.1 Standard of Acceptance
- Tek-Air model Iso-Tek
- TSI
- Honeywell
- Phoenix Controls

.2 Monitor unit construction:

.1 industrial grade metal case mounted on an electrical junction box,

.2 local digital display control unit;
- Range: -50 to + 50 Pa (-0.19999 to +0.19999 in.wg.)
- Resolution: 5% of reading,
- Display updated every second,
- Spill-proof membrane keypad for programming,
- Local calibration protected by pass-code.

.3 Indicating lights:
- Low pressure alarm
- Normal
- High pressure alarm
- Audible Mute

.4 Audible alarm annunciates when pressure in monitored room is in alarm condition.
- Adjustable time-delay on alarm initiation for door opening,

.5 Remote alarm annunciation:
- High pressure alarm contact - contacts normally open.
- Low pressure alarm contact - contacts normally open

.3 Pressure Sensor:

.1 two velocity sensing elements mounted in-line to each other, with temperature compensating element;
- Pressure measurement accuracy: -50 to + 50 Pa (-0.19999 to +0.19999 in.wg.)
- Temperature compensation range: 12.7 to 35 °C (55 to 95 °F)

.2 Alarm setpoints:
- Low pressure: 2.5 Pa (0.01 in.wc.) relative to adjacent space,
- Resettable to any point over sensing range.

2.17 Building Pressure Control

.1 A dynamic Building Pressure Control System shall be provided to maintain the building pressurized relative to the outside.

.1 Building reference pressure shall be measured on the 2nd Floor

2.18 Sensors and Instrumentation

.1 All field sensors and instrumentation shall have a measurement range suitable to the application.

.2 All field sensors, instrumentation, and control loops shall meet the minimum performance requirements tabulated below.

Parameter	*Variable*	*Reporting Accuracy*	*Control Accuracy*	*Remarks*
Temperature	• space • ducted air • liquids • outside air • differential • dew point • low limit (Freezestat)	±0.25°C (±0.50°F) ±0.5°C (±1.0°F) ±0.15°C (±0.25°F) ±1.0°C (±2.0°F)	±1.0°C (±2.0°F)	RTD type • 3 attempts at Automatic Reset before lockout • range:1.7°C to 7.2°C (35°F to 45°F) • field adjustable
Humidity	• relative humidity	± 3%	± 5%	Electronic type Range: 10-100% RH
Pressure	Air • ducts / space • static / differential	± 1%	± 5Pa (±0.02”w.g)	Electronic type • for compressed air see Liquids requirements
	Liquids • absolute / static / differential	± 1%	± 1.5 psi	
Flow	Air • proving switch	± 1% full scale -	± 10% full scale	Multiple-head Pitot Tube Type or Thermal Anemometer Probe Type • differential pressure activated diaphragm type
	Liquids • flow switch	± 2% full scale -		 • differential pressure activated paddle type
Gas Detection	• CO • CO_2	± 3% ± 5 ppm		

3 INSTALLATION STANDARDS

3.1 General

.1 The requirements outlined in the following clauses are applicable to all BAS Installation. Application Specific requirements are outlined under clauses 3.2 – 3.13

.2 All campus network drops required to complete the BAS installation shall be provided by the BAS Contractor.
  .1 Extend network a connection(s) from the nearest IT/Communications Closet; coordinate this activity with the Electrical/Communications contractor.

3.2 BAS Panels & Cabinets

.1 Install Building Control Units, Equipment Control Units, and Field Panels in cabinets.
  .1 cabinets shall be mounted on a painted non-combustible backboard which is rigidly mounted to a wall or on a galvanized steel, floor mounted support frame.
    - installation on ductwork, equipment, and locations subject to vibration is not acceptable
    - cabinets for Terminal Equipment Controllers may be installed on the terminal equipment provided there is no vibration that could affect controller operation or calibration of control device(s).
  .2 cabinets to be sized to accommodate 20% future I/O points.
  .3 cabinet locations are to be coordinated with other trades and the general contractor.
.2 No panels (except Terminal Equipment Controllers) shall be installed in the ceiling space or at an elevation inaccessible for normal & ready access from the finished floor.

3.3 BAS Wiring

.1 Wiring:
  .1 wiring shall be installed in conduit, raceways and enclosures separated from other wiring.
  .2 wiring may be installed without conduit in the interstitial space above finished ceilings provided the following conditions are met:
    - wiring has a minimum rating of FT6; and
    - interstitial ceiling space is within the room where final termination of wire will be made
  .3 each run of communication wiring to be continuous length without splices
  .4 wiring within BCU's, ECU's and Field Panels (Cabinets) shall be installed in a plastic tray with a removable cover
    - wiring shall be terminated at field-removable, modular terminal strips
  .5 connections within cabinets and panels shall be done using terminals
    - wire nuts and Marr connections are not acceptable
  .6 wiring to field sensors shall not be daisy-chained
  .7 should it become necessary to splice field wiring it shall be soldered and a 500mm (20in.) loop length is to be provided
    - wire nuts and Marr connections are not acceptable
    - if soldering is not possible approved B-type crimp connectors are an acceptable alternative
.2 Conduit:
  .1 thin wall (EMT) conduit up to and including 32mm (1¼") size for exposed wiring up to 3 m (10 ft) above floor level
  .2 rigid galvanized steel conduit in locations accessible to public, subject to mechanical injury, or outdoors; and for conduit 40mm (1½") size and larger
  .3 conduit to be parallel with, or at right angles to, building walls
  .4 concealed within finished shafts, ceilings, and walls where possible
  .5 route all conduit to clear beams, plates, footings, and structural members
  .6 watertight compression fittings in exterior locations
  .7 provide watertight seals at penetrations through outside walls

.8 conduits leaving a building to the outside shall be sealed internally to prevent moist air from being pulled through the conduits, condensing, and then the water freezing inside the conduit

.9 empty or unused conduit openings and stubs to be plugged or capped with compatible fittings

- plugs or caps on conduit openings are to be maintained during construction

.10 conduits travelling between separate pressure regime areas shall be sealed internally to prevent migration of air and odors

.11 conduit to field sensors shall not be daisy chained

.3 Flexible conduit:

.1 shall be provided for the final conduit run to vibrating or rotating equipment so that vibration and equipment noise is not transmitted to the rigid conduit

- minimum 450mm (18in.) / maximum 900mm (36in.)

.2 shall be provided for the last 450mm (18 in.) of conduit runs to field sensors

- a junction box / enclosure shall be provided for terminations

.3 waterproof flexible conduit to be provided where exposed to weather or in damp or wet locations

.4 Lightning arrester shall be provided according to manufacturer's recommendations between the communication cable and ground wherever cable enters or exits building.

3.4 Air Handling Units

.1 At a minimum instrumentation shall be provided at each Air Handling Unit to monitor the following:

.1 Outside Air Temperature (may be common to a building)
.2 Return Air Temperature
.3 Mixed Air Temperature
.4 Filter Pressure Drop across each bank of filters
.5 Air Temperature Upstream & Downstream of all Coils
.6 Supply Air Relative Humidity
.7 Supply Air Static Pressure
.8 Supply Air Flow
.9 Supply Fan Speed (where fan is equipped with a Variable Frequency Drive)
.10 Return Air Relative Humidity
.11 Return Fan Speed (where fan is equipped with a Variable Frequency Drive)
.12 Return Air CO2 sensor.

3.5 Heating & Cooling Coils

.1 A water temperature sensor shall be provided on the inlet and outlet of each coil installed within an air handling unit.

.2 An air temperature sensor shall be provided upstream and downstream of each coil installed within an air handling unit.

3.6 Reheat Coils & VAV Boxes

.1 An air temperature sensor shall be provided downstream of each reheat coil.

.2 Air temperature sensors shall be provided such that the discharge temperature of each VAV can be measured.

3.7 Terminal Units

.1 Terminal units shall be equipped with an Air-flow Monitoring device interfaced with the BAS.

3.8 Heat Exchangers

.1 Temperature sensors shall be provided on the inlet and outlet of each heat exchanger.

.2 Where a dual (or triple) heat exchanger system is used temperature sensors shall be provided on the outlet of each exchanger plus a common sensor for the mixed outlet.

3.9 Steam

.1 A pressure sensor shall be provided downstream of every PRV station.

.2 A pressure sensor shall be provided on the building's incoming high pressure steam line.

3.10 Compressed Air

.1 A pressure sensor shall be provided on the building's incoming compressed air line (if present).

3.11 Water

.1 A pressure sensor shall be provided on the building's incoming domestic water line.

.2 A pressure sensor shall be provided on the building's incoming deionized water line (if present).

.3 Pressure and temperature sensors shall be provided on the building's incoming chilled water supply and chilled water return lines.

3.12 Identification

.1 Point Object Numbering systems shall include the Building Number as a prefix to all object identifiers. (eg. <99.AC1.SAT> is Building 99 Air Handling Unit 1 Supply Air Temperature).

.2 All Equipment shall be identified in accordance with the University's Identification Standards and numbering convention. Equipment numbers are to be provided by the University's PM Scheduler.

.3 Equipment numbering strategy shall be presented for review/approval by the Manager, Mechanical Design, DEC and Manager, Maintenance & Energy Services prior to completion of Design Development.

.4 Wiring

.1 All wires shall be tagged at both ends. The tagging shall identify the device a wire is connected to. Use of the point object name is an acceptable means of device identification.

.2 All junction boxes shall be tagged "BAS" with a sequential number suffix.

.5 Control Devices shall be labelled using a Blue Flag Tie-Marker, such as Nelco PT#N-9L (or equivalent). Labels shall be white or yellow with large black text.

.6 All local alarm devices (lights, strobes, horns, etc.) shall be clearly labelled as to their purpose with an appropriately sized lamacoid plastic plate that is securely affixed so as to be visible and legible from the direction of normal approach.

.1 Prior to fabrication, proposed alarm device labels (wording, size, colors) shall be presented for review/approval by the Manager, Mechanical Design, DEC and Manager, Maintenance & Energy Services.

3.13 Redundant or Obsolete Pneumatic, Electric, Electronic, and DDC Devices

.1 Existing BAS control equipment rendered redundant or obsolete by the installation of a new BAS system or component shall be removed to the greatest extent possible.

.1 control drawings and graphics shall be updated accordingly.

.2 Removal shall include the clean-up, removal, and proper termination of all existing pneumatic equipment (tubing, piping, panels, actuators, sensors, etc.), existing electronics (wiring, conduit, actuators, sensors) or existing DDC system (controllers, cabinets, sensors, relays, transformers, power supplies, etc.) no longer used by the BAS.

.1 ductwork or walls affected shall be patched and sealed or covered with a suitable wall plate

.2 removal may require the re-piping or rewiring of existing BAS control equipment that is to remain

.3 pneumatic tubing or piping that cannot be removed shall be suitably plugged to prevent air leakage. Crimping or folding of tubing/piping is not acceptable.

.4 wiring remaining shall be suitably terminated

.3 Removal shall occur immediately after commissioning of the new control system in the building is complete.

4 VERSION CONTROL SUMMARY

Revision No.	Effective Date	Section / Page	Brief Description of Revision
0	15-09-2014	Entire Standard	Original Issue

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International).

.1 CSA C22.1-02, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to Consultant for approval samples of nameplates, identification tags and list of proposed wording.

PART 2 - PRODUCTS

2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain plastic tie.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high produced from laser printer in black.

.4 Data to include: point name and point address.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Consultant.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative's DCC Representative's Consultant's.

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 PNEUMATIC TUBING

.1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and confirm colour with Consultant during "Preliminary Design Review".

PART 3 - EXECUTION

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing nameplates and legends to reflect changes made during Work.

END OF SECTION

PART 1- GENERAL

1.1 SYSTEM DESCRIPTION

.1 Electrical:
- .1 Provide power wiring from locations as indicated on Div 26 drawings for room mounted controllers.
- .2 Provide power from existing emergency power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
- .3 Hard wiring between field control devices and EMCS field panels.
- .4 Communication wiring between EMCS field panels and OWS's including main control centre BECC.

.2 Mechanical:
- .1 Pipe Taps Required For EMCS equipment will be supplied and installed by Division 22 and Division 23.
- .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Division 23.
- .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.

.3 VAV Terminal Units.
- .1 Air flow probe for VAV boxes to be supplied and installed under Section 23 36 00 - Air Terminal Units. Air flow dp sensor, actuator and associated VAV controls to be supplied and installed by EMCS contractor. Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.

PART 2- PRODUCTS

2.1 WIRING

.1 As per requirements of Division 26.

.2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.

.4 Sizes:
- .1 120V Power supply: to match or exceed breaker, size #12 minimum.

.5 Terminations:
- .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.2 CONDUIT

.1 As per requirements of Division 26.

.2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.

.3 Junction and pull boxes: welded steel.
- .1 Surface mounting cast FS: screw-on flat covers.
- .2 Flush mounting: covers with 25 mm minimum extension all round.

.4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.5 Outlet boxes: 100 mm minimum, square.

.6 Conduit boxes, fittings:
- .1 Bushings and connectors: with nylon insulated throats.
- .2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:
- .1 Couplings and fittings: threaded type steel.
- .2 Double locknuts and insulated bushings: use on sheet metal boxes.
- .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:
- .1 Connectors and couplings: steel, set screw type.

2.3 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.2 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.3 Exposed conduits or cables:
- .1 50 mm diameter and smaller: one-hole steel straps.
- .2 Larger than 50 mm diameter: two-hole steel straps.

.4 Suspended support systems:
- .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
- .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

3.2 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:
- .1 Division 26, this specification.
- .2 CSA 22.1 Canadian Electrical Code.
- .3 ANSI/NFPA 70.
- .4 ANSI C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.

.3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.

.4 Conform to manufacturer's recommendations for storage, handling and installation.

.5 Check factory connections and joints. Tighten where necessary to ensure continuity.

.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.9 Install conduits, and sleeves prior to pouring of concrete.

.10 Holes through exterior wall and roofs: flash and make weatherproof.

.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.3 CONDUIT SYSTEM

.1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.

.2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Consultant before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:
- .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
- .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
- .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Consultant.

.10 Install polypropylene fish cord in empty conduits for future use.

.11 Where conduits become blocked, remove and replace blocked sections.

.12 Pass conduits through structural members only after receipt of Consultant's written approval.

.13 Conduits may be run in flanged portion of structural steel.

.14 Group conduits wherever possible on suspended or surface channels.

.15 Pull boxes:
- .1 Install in inconspicuous but accessible locations.
- .2 Support boxes independently of connecting conduits.
- .3 Fill boxes with paper or foam to prevent entry of construction material.
- .4 Provide correct size of openings. Reducing washers not permitted.
- .5 Mark location of pull boxes on record drawings.
- .6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install bonding conductor for 120 volt and above in conduit.

3.4 WIRING

.1 Install multiple wiring in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:
- .1 Circuits are continuous, free from shorts, unspecified grounds.
- .2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Consultant with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.5 WIRING DEVICES, COVER PLATES

.1 Receptacles:
- .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.

.2 Cover plates:
- .1 Install suitable common cover plate where wiring devices are grouped.
- .2 Use flush type cover plates only on flush type outlet boxes.

3.6 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section includes:

.1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, and valve actuators.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 33 00 – Submittal Procedures.

.2 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Meet the requirements of University of Guelph, Physical Resources, Design engineering and Construction, Design Standards DSM-03

.2 Building Automation Systems Control devices of each category to be of same type and manufacturer.

.3 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.4 Transmitters and sensors to be unaffected by external transmitters including walkie-talkies.

.5 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.6 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

2.2 TEMPERATURE SENSORS

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 20 degrees C and over.

.2 RTD's: 100 or 1000 ohm at 0degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored lead wires, Coefficient of resistivity: 0.00385 ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.

.6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm.

.2 Room temperature sensors and display wall modules.

.1 Temperature sensing and display wall module.

.1 LCD display to show space temperature and temperature setpoint.

.2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.

.3 Jack connection for plugging in laptop personal computer for access to zone bus.

.4 Integral thermistor sensing element 10,000 ohm at 24 degrees.

.5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.

.6 Stability 0.02 degrees C drift per year.

.7 Separate mounting base for ease of installation.

.2 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed aluminum finish.

.3 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations.

.4 Outdoor air temperature sensors:

.1 Outside air type: complete with probe, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.

.2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.

.3 Output signal: 4 - 20 mA into 500 ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.

.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.

.7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 degrees C.

.10 Transmitter ranges: to suit application.

2.4 HUMIDITY SENSORS

.1 Room and Duct Requirements:

.1 Range: 5 - 90 % RH minimum.

.2 Operating temperature range: 0 - 60 degrees C.

.3 Absolute accuracy: plus or minus 3%.

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.

.5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.

.6 Duct mounted sensors: locate so that sensing element is in air flow in duct.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

.1 Input signal: from RH sensor.

.2 Output signal: 4 - 20 mA onto 500 ohm maximum load.

.3 Input and output short circuit and open circuit protection.

.4 Output variations: not to exceed 0.2 % of full scale output for supply voltage variations of plus or minus 10 %.

.5 Output linearity error: plus or minus 1.0% maximum of full scale output.

.6 Integral zero and span adjustment.

2.6 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Combined sensor and transmitter measuring pressure.

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA into 500 ohm maximum load.

.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.

.5 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.

.6 Over-pressure input protection to at least twice rated input pressure.

.7 Output short circuit and open circuit protection.

.8 Accuracy: plus or minus 1% of Full Scale.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA into 500 ohm maximum load.

.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 STATIC PRESSURE SENSORS

.1 Requirements:

.1 Multipoint element with self-averaging manifold.

.1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).

.2 Accuracy: plus or minus 1 % of actual duct static pressure.

2.9 STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.

.2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.

.3 Accuracy: 0.4 % of span.

.4 Repeatability: within 0.5 % of output.

.5 Linearity: within 1.5 % of span.

.6 Deadband or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.10 SUMP LEVEL SWITCHES

.1 Requirements:

.1 Liquid level activated switch sealed in waterproof and shockproof enclosure.

.2 Complete with float, flexible cord, weight. Instrument casing to be suitable for immersion in measured liquid.

.3 N.O./N.C. Contacts rated at 15 amps at 120V AC. CSA approval for up to 250 volt 10 amps AC.

2.11 CURRENT SENSING RELAYS

.1 Requirements:

.1 Suitable to detect belt loss or motor failure.

.2 Trip point adjustment, output status LED.

.3 Split core for easy mounting.

.4 Induced sensor power.

.5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.

.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.

.7 Adjustable latch level.

2.12 CONTROL DAMPERS

.1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 1219 mm high. Three or more sections to be operated by jack shafts.

.2 Materials:

.1 Frame: 2.03 mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.

.2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.

.3 Bearings: maintenance free, synthetic type of material.

.4 Linkage and shafts: aluminum, zinc and nickel plated steel.

.5 Seals: synthetic type, mechanically locked into blade edges.

.1 Frame seals: synthetic type, mechanically locked into frame sides.

.3 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
- .1 Size/Capacity: refer to damper schedule
- .2 25 L/s/m² maximum allowable leakage against 1000 Pa static pressure for outdoor air and exhaust air applications.
- .3 Temperature range: minus 40degrees C to plus 100 degrees C.

.4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

.5 Jack shafts:
- .1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
- .2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
- .3 Install using manufacturers installation guidelines.
- .4 Use same manufacturer as damper sections.

2.13 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 Requirements:
- .1 Direct mount proportional type as indicated.
- .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
- .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
- .4 Power requirements: 5 VA maximum at 24 V AC.
- .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
- .6 For VAV box applications floating control type actuators may be used.
- .7 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

2.14 PERIMETER RADIATION AND FAN COIL CONTROL VALVES

.1 Body: characterized ball.
- .1 Flow characteristic as indicated on control valve schedule: equal percentage.
- .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
- .3 Normally open (Heating Applications) or Normally closed (Cooling Applications).
- .4 Two port, as indicated.
- .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
- .6 Stem, stainless steel.
- .7 NPS 2 and under:
  - .1 Screwed National Pipe Thread (NPT) tapered female connections.
  - .2 Valves to ANSI Class 125, valves to bear ANSI mark.
- .8 Rangeability 50:1 minimum.

2.15 AHU CONTROL VALVES

.1 Body: globe style.
- .1 Flow characteristic as indicated on control valve schedule: equal percentage.
- .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
- .3 Normally open (Heating Applications) or Normally closed (Cooling Applications).
- .4 Two port, as indicated.
- .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
- .6 Packing easily replaceable.
- .7 Stem, stainless steel.
- .8 Plug and seat, stainless steel.
- .9 Disc, replaceable, material to suit application.
- .10 NPS 2 and under:
  - .1 Screwed National Pipe Thread (NPT) tapered female connections.
  - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
  - .3 Rangeability 50:1 minimum.
- .11 NPS 2½ and larger:
  - .1 Flanged connections.
  - .2 Valves to ANSI Class 150 as indicated, valves to bear ANSI mark.
  - .3 Rangeability 100:1 minimum.

2.16 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:
- .1 Construction: steel, cast iron, aluminum.
- .2 Control signal: 0-10V DC or 4-20 mA DC.
- .3 Positioning time: to suit application.
- .4 Fail to normal position as indicated.
- .5 Scale or dial indication of actual control valve position.
- .6 Size actuator to meet requirements and performance of control valve specifications.
- .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
- .8 Minimum shut-off pressure: refer to control valve schedule.

2.17 PANELS

.1 Wall mounted enameled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional without adding additional cabinets.

.3 Panels to be lockable with same key.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

.5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 – Fire stopping. Maintain fire rating integrity.

.6 VAV Terminal Units: supply, install and adjust as required.

- .1 Air probe, actuator and associated VAV controls.
- .2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.
- .3 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:

- .1 Protect from solar radiation and wind effects by non-corroding shields.
- .2 Install in NEMA 4 enclosures.

.4 Duct installations:

- .1 Do not mount in dead air space.
- .2 Locate within sensor vibration and velocity limits.
- .3 Securely mount extended surface sensor used to sense average temperature.
- .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
- .5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.

- .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
- .2 Wire multiple sensors in series for low temperature protection applications.
- .3 Wire multiple sensors separately for temperature measurement.
- .4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells: install for piping installations.

.1 Locate well in elbow where pipe diameter is less than well insertion length.

.2 Thermowell to restrict flow by less than 30%.

.3 Use thermal conducting paste inside wells.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.3 Identify wiring and conduit clearly.

3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.

.2 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.5 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Commissioning.

END OF SECTION

PART 1 - GENERAL

1.1 COMMISSIONING DESCRIPTION

.1 The Electrical Contractor will assist in the commissioning of all electrical equipment, fire alarm system, lighting control system, and electrical systems for mechanical equipment within the building. The Contractor will appoint a person who will be responsible for the electrical commissioning process in conjunction with the commissioning manager.

.2 The appointed electrical representative will be part of the building commissioning team and be required to attend all scheduled commissioning progress meetings.

.3 Should any factors such as lack of occupancy prevent start-up of any electrical equipment or systems within the construction /commissioning stage of the Project; the Manufacturer will carry out these performance testing procedures at any time within the 12-month warranty period of the contract.

.4 Refer to Section 01 91 13 – Commissioning for more information on the building commissioning process

1.2 COMMISSIONING REQUIREMENTS

.1 The electrical representative will be responsible for coordination of electrical system start-up. The representative will schedule these system start-ups, including all manufacturer assisted start-ups, based on the overall building start-ups schedule as provided by the commissioning manager.

.2 The electrical representative will complete all equipment information forms as supplied in the specification or provided by the commissioning manager. The information will detail the building electrical equipment as installed.

.3 The point to point verification for the Fire Alarm and Lighting Control systems will be documented and submitted to the commissioning manager and design engineer for review and acceptance. The commissioning manager will review the point-to-point verification of these systems.

.4 The electrical trade contractor will document all equipment start-up and testing, as detailed herein. The system testing will include, but not be limited to, the following:

.1 Pre-service main incoming power and switchboard verification.
.2 Post-service power distribution and grounding.
.3 Fire alarm system certification.
.4 Lighting control system.
.5 Facility failure mode verification.

.5 The proper operation of all building electrical distribution systems must be proven by the electrical trade prior to Phase 3 (Functional Verification) of the building commissioning process.

.6 The electrical contractor will verify the sequence of operation for the fire alarm and lighting control systems during the functional verification commissioning process. The system functional testing will be carried out by the system manufacturer representative and be observed by the commissioning manager and any other member of the commissioning team.

.7 All system start-up/testing documentation, authority inspection reports and equipment information forms will be submitted by the trade contractor to the commissioning manager for inclusion into the commissioning manual.

.8 The electrical trade representative will participate in the building failure mode test. The failure mode test will take place over a one-day period. The basis for the failure mode testing will be loss of normal power to the facility. The test will be a dynamic, in that all building systems will be in normal running operation. The building power will be transferred from normal to emergency and all building systems will be observed. The building will then be restored to normal power. The failure mode test observations will be documented in a separate report by the commissioning manager.

.9 The electrical contractor is responsible for training and instruction to the owner on the electrical systems and equipment once the commissioning verification process is complete. The Contractor will also coordinate and schedule all fire alarm and lighting control system instruction sessions.

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 SCOPE

.1 The Contractor to furnish short-circuit and protective device coordination studies as prepared by the equipment manufacturer.

.2 The Contractor to furnish an Arc-Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.2 REFERENCES

.1 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
- .1 IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
- .2 IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
- .3 IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
- .4 IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
- .5 IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
- .6 IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

.2 American National Standards Institute (ANSI):
- .1 ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
- .2 ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
- .3 ANSI C37.010 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

.3 The National Fire Protection Association (NFPA):
- .1 NFPA 70 – National Electrical Code, latest edition.
- .2 NFPA 70E – Standard for Electrical Safety in the Workplace.

1.3 SUBMITTALS FOR REVIEW

.1 The short-circuit and protective device coordination studies to be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Consultant may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.4 SUBMITTALS FOR CONSTRUCTION

.1 The results of the short circuit, protective device coordination and Arc-Flash Hazard analysis studies to be summarized in a final report. No more than five (5) bound copies of the complete final report to be submitted, as well as on CD in PDF format.

.2 The report to include the following sections:
- .1 One-line diagram.
- .2 Descriptions, purpose, basis and scope of the study.

.3 Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.

.4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.

.5 Fault current calculations including a definition of terms and guide for interpretation of the computer printout.

.6 Incident energy and flash protection boundary calculations.

.7 Recommendations for system improvements, where needed.

.8 Executive Summary.

1.5 QUALIFICATIONS

.1 The short-circuit, protective device coordination and Arc-Flash Hazard analysis studies to be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer to be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCTS

2.1 STUDIES

.1 Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.

.2 The Contractor to furnish an Arc-Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

.3 The short circuit and protective device coordination study and the Arc flash Hazard analysis shall be carried out for building Wings A, B and C.

2.2 DATA COLLECTION

.1 Contractor to furnish all data as required by the power system studies. The Consultant performing the short-circuit, protective device coordination and Arc-Flash Hazard Analysis studies to furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor to expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

.2 Source combination may include present and future motors and generators.

.3 Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

.4 Include fault contribution of existing motors in the study, with motors < 100 hp grouped together. Contractor to obtain required existing equipment data, if necessary, to satisfy the study requirements.

.5 Obtain from local utility, fault level characteristics available at building entrance switchgear.

.6 Verify cable lengths of existing feeders for panels in Wing A to remain and incorporate details in study.

2.3 SHORT-CIRCUIT AND PROTECTION DEVICE EVALUATION STUDY

.1 Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141-1993.

.2 Transformer design impedances to be used when test impedances are not available.

.3 Provide the following:
- .1 Calculation methods and assumptions.
- .2 Selected base per unit quantities.
- .3 One-line diagram of the system being evaluated.
- .4 Source impedance data, including electric utility system and motor fault contribution characteristics.
- .5 Typical calculations.
- .6 Tabulations of calculated quantities.
- .7 Results, conclusions, and recommendations.

.4 Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
- .1 Electric utility's supply termination point.
- .2 Incoming switchgear.
- .3 Unit substation primary and secondary terminals.
- .4 Low voltage switchgear.
- .5 Motor control centres.
- .6 Standby generators and automatic transfer switches.
- .7 Branch circuit panel boards.
- .8 Other significant locations throughout the system.

.5 For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

.6 Protective Device Evaluation:
- .1 Evaluate equipment and protective devices and compare to short circuit ratings.
- .2 Adequacy of switchgear, motor control centres, and panel board bus bars to withstand short-circuit stresses.
- .3 Adequacy of transformer windings to withstand short-circuit stresses.
- .4 Cable and busway sizes for ability to withstand short-circuit heating.
- .5 Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

.1 Proposed protective device coordination time-current curves to be graphically displayed on log-log scale paper.

.2 Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

.3 Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

.4 Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

.5 Plot the following characteristics on the curve sheets, where applicable:
- .1 Electric utility's protective device.
- .2 Medium voltage equipment relays.
- .3 Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
- .4 Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
- .5 Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters.
- .6 Conductor damage curves.
- .7 Ground fault protective devices, as applicable.
- .8 Pertinent motor starting characteristics and motor damage points.
- .9 Pertinent generator short-circuit decrement curve and generator damage point.
- .10 Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor centre.

.6 Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC-FLASH HAZARD ANALYSIS

.1 The Arc-Flash Hazard analysis to be performed according to the IEEE 1584 equations that are presented in NFPA 70E-2004, Annex D.

.2 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods to be presented in the proposal.

.3 The flash protection boundary and the incident energy to be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centres, panel boards, busway and splitters) where work could be performed on energized parts.

.4 The Arc-Flash Hazard Analysis to include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

.5 Safe working distances to be specified for calculated fault locations based upon the calculated Arc Flash boundary considering an incident energy of 1.2 cal/cm^2.

.6 The Arc-Flash Hazard analysis to include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation to assume that the utility contribution is at a minimum and to assume a maximum contribution from the utility and to assume motors to be operating under full-load conditions.

.7 Arc Flash computation to include both line and load side of main breaker calculations, where necessary.

.8 Arc-Flash calculations to be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.6 REPORT SECTIONS

.1 Input Data:
- .1 Short-circuit reactance of rotating machines.
- .2 Cable and conduit materials.

.3 Bus ducts.
.4 Transformers.
.5 Automatic transfer switches.
.6 Reactors.
.7 Aerial lines.
.8 Circuit resistance and reactive values.

.2 Short-Circuit Data:
.1 Source fault impedance and generator contributions.
.2 X to R ratios.
.3 Asymmetry factors.
.4 Motor contributions.
.5 Short circuit kVA.
.6 Symmetrical and asymmetrical fault currents.

.3 Recommended Protective Device Settings:
.1 Phase and Ground Relays:
.1 Current transformer ratio.
.2 Current setting.
.3 Time setting.
.4 Instantaneous setting.
.5 Specialty non-overcurrent device settings.
.6 Recommendations on improved relaying systems, if applicable.
.2 Circuit Breakers:
.1 Adjustable pick-ups and time delays (long time, short time, ground).
.2 Adjustable time-current characteristic.
.3 Adjustable instantaneous pick-up.
.4 Recommendations on improved trip systems, if applicable.

.4 Incident Energy and Flash Protection Boundary Calculations:
.1 Arcing fault magnitude.
.2 Device clearing time.
.3 Duration of arc.
.4 Arc-Flash boundary.
.5 Working distance.
.6 Incident energy.
.7 Hazard Risk Category.
.8 Recommendations for Arc-Flash energy reduction.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

.1 Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Start-up and Acceptance Testing contract portion.

.2 Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

.3 Notify Owner in writing of any required major equipment modifications.

.4 Following completion of all studies, acceptance testing and start up by the field engineering service division of the equipment manufacturer, a 2-year warranty to be provided on all components manufactured by the engineering service parent manufacturing company.

3.2 ARC-FLASH WARNING LABELS

.1 The vendor to provide a 3.5" x 5" thermal transfer type label of high adhesion polyester for each work location analyzed. The format of the label shall be approved by the University of Guelph. Sample label to be provided for approval.

.2 The label to have an orange header with the wording "WARNING, ARC-FLASH HAZARD", and to include the following information:

- .1 Location designation.
- .2 Nominal voltage.
- .3 Flash protection boundary.
- .4 Hazard risk category.
- .5 Incident energy.
- .6 Working distance.
- .7 Engineering report number, revision number and issue date.

.3 Labels to be machine printed, with no field markings.

.4 Arc-Flash labels to be provided in the following manner and all labels to be based on recommended overcurrent device settings:

- .1 For each 600, 480 and applicable 208 volt panel boards, one Arc-Flash label to be provided.
- .2 For each motor control centre, one Arc-Flash label to be provided.
- .3 For each low voltage switchboard, one Arc-Flash label to be provided.
- .4 For each switchgear, one flash label to be provided.
- .5 For medium voltage switches one Arc-Flash label to be provided.

.5 Labels to be field installed by the engineering service division of the equipment manufacturer under the Start-up and Acceptance Testing contract portion.

.6 The label format shall also meet the University standards and shall be approved prior to installation.

3.3 ARC-FLASH TRAINING

.1 The equipment vendor to train personnel of the potential Arc-Flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, to be provided in the equipment manuals. The training to be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Division 01.

.2 Electrical Specifications.

.3 Communications Specifications.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA C22.1-06, Canadian Electrical Code, Part 1 (20th Edition), Safety Standard for Electrical Installations.
- .2 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC):
- .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switchgear.

.3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC):
- .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 DEFINITIONS

.1 Electrical and electronic terms: Unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.4 DESIGN REQUIREMENTS

.1 Operating voltages: To CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: Provide identification nameplates and labels for control items in English.

.4 Use one nameplate or label for each language.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit for review single line electrical diagrams in glazed frames and locate as indicated.
- .1 Electrical distribution system in main electrical room.

.3 Submit for review fire alarm riser diagram, plan and zoning of building in glazed frames at fire alarm control panel, annunciator and at the main fire alarm panel/annunciator at Building 049.

.4 Shop drawings:

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

.2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure coordinated installation.

.3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

.4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

.5 Submit two (2) of 600 x 600 mm minimum size drawings and product data to authorities having jurisdiction and inspection authorities.

.6 If changes are required, notify Consultant of these changes before they are made.

.7 The review of Contractor prepared submissions (shop drawings, reports, etc.) by the Consultant is not to be considered part of the Contractor Quality Assurance Program.

.8 Provide CSA certified equipment and materials.

.9 Where CSA certified equipment and materials are not available, submit such equipment and material to authorities having jurisdiction and inspection authorities for special approval before delivery to site.

.10 Submit test results of installed electrical systems and instrumentation.

.11 Permits and fees: In accordance with General Conditions of contract.

.12 Submit, upon completion of Work, load balance report as described in PART 3 – LOAD BALANCE.

.13 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative Consultant Engineer.

.5 Manufacturer's Field Reports: submit manufacturer's written report to Consultant, within three (3) days of review, verifying compliance of Work, and electrical system, and instrumentation testing, as described in PART 3 – FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

.1 Quality Assurance: In accordance with Section 01 45 00 – Quality Control.

.2 Qualifications: Electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of the Provincial Act respecting manpower vocational training and qualification.

.1 Employees registered in provincial apprentices program: Permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

.2 Permitted activities: Determined based on training level attained and demonstration of ability to perform specific duties.

.3 Site Meetings: as part of Manufacturer's Field Services described in Part 3 – FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.

.1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.

.2 During progress of Work.

.3 Upon completion of Work, after cleaning is carried out.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: Provide Consultant with schedule within 2 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

1.8 SYSTEM START-UP

.1 Instruct Consultant and operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

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

.4 Provide 72 hours written notice for de-energizing, transferring and re-energizing of any and all systems. Arrange and pay for all associated costs outside normal working hours.

1.9 OPERATING INSTRUCTIONS

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:
- .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- .3 Safety precautions.
- .4 Procedures to be followed in event of equipment failure.
- .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.

.2 Factory assemble control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and coordination responsibilities related to motors, equipment and controls, as indicated.

.2 Control wiring and conduit: In accordance with Section 26 29 03 – Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.3 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of the authority having jurisdiction.

.2 Porcelain enamel signs, minimum size 175 x 250 mm.

2.4 WIRING TERMINATIONS

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

2.5 EQUIPMENT IDENTIFICATION

.1 Identify all electrical equipment supplied under this Division as per approval and to meet the standards of the University of Guelph. Hand-painted identification will not be accepted.

.2 Identify electrical equipment with nameplates and labels to maintain the design criteria for the existing installation per University Design Standards, and as follows:

.1 Nameplates for normal power equipment: lamacoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core and mechanically attached with self-tapping screws.

.2 Nameplates for essential power equipment: lamacoid 3 mm thick plastic engraving sheet, orange face, white core, lettering accurately aligned and engraved into core and mechanically attached with self-tapping screws.

.3 Sizes as follows:

Nameplate Sizes

(Metric)	DIMENSIONS	# LINES	LETTER HEIGHT
Size 1	10 x 50 mm	1	3 mm
Size 2	12 x 70 mm	1	5 mm
Size 3	12 x 70 mm	2	3 mm
Size 4	20 x 90 mm	1	8 mm
Size 5	20 x 90 mm	2	5 mm
Size 6	25 x 100 mm	1	12 mm
Size 7	25 x 100 mm	2	6 mm
Size 8	50 x 150 mm	1	25 mm
Size 9	75 x 150 mm	2	19 mm

.3 Labels: Embossed plastic labels with 6 mm high letters unless specified otherwise. Secure each label with 2 self-tapping screws or tie to cables with Ty-raps.

.4 Wording on nameplates and labels to be approved by Consultant prior to manufacture.

.5 Allow for minimum of 25 letters per nameplate and label.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.8 Terminal cabinets and pull boxes: indicate system and voltage.

.9 Transformers: Indicate capacity, primary and secondary voltages.

.10 Panel nameplates, size 7, to identify panels, as indicated, and voltage characteristics.

.11 For distribution panels provide a nameplate, size 5, for each circuit appropriately engraved identifying equipment or panel controlled.

.12 For branch circuit panels provide a typed directory inside door of each panel stating type of load and room location for each circuit. Supply a protective plastic envelope for directory.

.13 Identify circuit numbers on back of receptacle and switches with wire markers.

.14 Correct existing panel legends and nameplates to reflect changes made.

.15 Transformer nameplates, size 7, to show capacity, primary and secondary voltages.

.16 Nameplates, size 5, for disconnect switches, splitters and contactors to indicate equipment being controlled, voltage characteristics, ampere or horsepower kilowatt rating of equipment.

.17 Nameplate for each manual starter to be size 1 engraved "name of equipment controlled".

.18 Nameplate for each magnetic starter to be size 3 engraved "name of equipment controlled".

.19 Nameplate on each remote control device to be size 1 engraved "name of equipment controlled".

.20 Nameplates, size 5, for terminal cabinets, pull boxes and junction boxes to indicate system and/or voltage characteristics.

.21 At underground service entrance, size 9 on outside wall stating "Underground Service Entrance".

.22 Identify equipment with size 3 labels engraved “Asset Inventory No. ...” Number as, and if, directed by Consultant.

2.6 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: To CSA C22.1.

.4 Use colour codes wires in communication cables, matched throughout system.

2.7 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes, and metallic sheathed cables.

.2 Coding to be located on all conduits and cables exposed after completion of building and in suspended removable ceilings.

.3 Coding to be plastic tape or paint at all points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.4 Colours to be 25 mm" wide prime colour and 20 mm wide auxiliary colour.

	Prime	**Auxiliary**
Up to 250 V	Yellow	
Up to 600 V	Yellow	Green
Up to 5 kV	Yellow	Blue
Up to 15 kV	Yellow	Red
Fire Alarm	Red	

2.8 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .1 Paint outdoor electrical equipment "equipment green" finish.
- .2 Paint indoor switchgear and distribution enclosures light grey.
- .3 All electrical equipment/panels indicated as fed from back-up power to be factory painted Omaha orange.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.3 Clean and prime exposed non-galvanized hangers, racks and fastenings.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

.2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.

.2 Sleeves through concrete: schedule 40 steel pipe sized for free passage of conduit, and protruding 50 mm.

.3 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.4 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

.5 Holes through exterior walls and roof to be flashed and made waterproof. Seal inside the conduit with suitable compound to prevent entry of water through conduit.

.6 Provide all cutting of chases, drilling holes and other structural work required to install electrical conduits, cables, pull boxes and outlet boxes.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.

.2 Do not install outlets back-to-back in wall; allow minimum150 mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

.4 Locate light switches on latch side of doors.
- .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

.5 Make all necessary adjustments when interior finish is completed.

.6 In acoustic tile and inverted "T" bar ceilings locate equipment in centre of tile or on "T" bar. Obtain location ruling from Consultant.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.
- .1 Local switches: 1100 mm.
- .2 Wall receptacles:
  - .1 General: 400 mm.
  - .2 Above top of continuous baseboard heater: 200 mm.
  - .3 Above top of counters or counter splash backs: 175 mm.
  - .4 In mechanical rooms: 1400 mm.
- .3 Panel boards: as required by Code or as indicated.
- .4 Fire alarm stations: 1200 mm.
- .5 Fire alarm bells: 2100 mm.
- .6 Television outlets: 1525 mm.
- .7 Clocks: 2100 mm.

3.6 COORDINATION OF PROTECTIVE DEVICES

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

3.7 FIELD QUALITY CONTROL

.1 Load Balance:

.1 Measure phase current to panel boards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 – SUBMITTALS: phase and neutral currents on panel boards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.2 Conduct following tests in accordance with Section 01 45 00 – Quality Control.

.1 Power distribution system, including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its control.

.4 Motors, heaters and associated control equipment, including sequenced operation of systems where applicable.

.5 Systems: fire alarm system communications.

.6 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.3 Carry out tests in presence of Consultant.

.4 Provide instruments, metres, equipment and personnel required to conduct tests during and at conclusion of project.

.5 Manufacturer's Field Services:

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

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

.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks, and fastenings to prevent rusting.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 CSA International:
- .1 CAN/CSA-C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.
- .2 CAN/CSA-C22.2 No.65-03(R2008), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC):
- .1 EEMAC 1Y-2-1961, Bushing Stud Connectors and Aluminum Adapters (1200 ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA).

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts sized to fit copper or aluminum conductors as required.

.2 Fixture type splicing connectors to: CAN/CSA-C22.2 No. 65, with current carrying parts copper conductors 10 AWG or less.

.3 Bushing stud connectors: to NEMA to consist of:
- .1 Connector body and stud clamp for stranded round copper conductors or bus bar.
- .2 Clamp for stranded round copper conductors.
- .3 Stud clamp bolts.
- .4 Bolts for copper conductors.
- .5 Sized for conductors as indicated.

.4 Clamps or connectors for armoured cable, TECK cable, mineral insulated cable, flexible metallic conduit as required to: CAN/CSA-C22.2 No.18.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connector installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Remove insulation carefully from ends of conductors and cables and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure-type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No. 65.

.3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No. 65. Replace insulating cap.

.4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Refer to Section 26 05 00 – Common Work Results for Electrical.

1.2 PRODUCT DATA

.1 Provide product data in accordance with Section 01 33 00 – Submittal Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Packaging Waste Management: Remove for reuse and return of pallets, crates, padding, and packaging materials.

PART 2 - PRODUCTS

2.1 BUILDING WIRES

.1 Conductors: Stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE or RWU90 XLPE in underground installations..

2.2 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90, RW90 XLPE – minimum size: 12 AWG.

.3 Armour: interlocking type fabricated from aluminum strip.

.4 Jacket Type: None.

.5 Connectors: anti-short connectors.

2.3 CONTROL CABLES

.1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
- .1 Insulation: thermoplastic.
- .2 Sheath: thermoplastic jacket.

.2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:
- .1 Insulation: TWH.
- .2 Shielding: tape coated with paramagnetic over each conductor pair.
- .3 Overall covering: PVC jackets.

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 Consultant and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

.1 Terminate cables in accordance with Section 26 05 20 – Wire and Box Connectors - (0-1000 V).

.2 Cable Colour Coding: to Section 26 05 00 – Common Work Results for Electrical.

.3 Conductor length for parallel feeders to be identical.

.4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

.6 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e., common neutrals not permitted.

.7 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

- .1 In conduit systems in accordance with Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.
- .2 In underground ducts in accordance with Section 33.
- .3 In surface and lighting fixture raceways in accordance with Section 26.

3.4 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible on channels.

3.5 INSTALLATION OF CONTROL CABLES

.1 Install control cables in conduit.

.2 Ground control cable shield.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE):
  .1 ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

.2 CSA International:
  .1 CSA Z32-09, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

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 grounding equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

1.4 RELATED REQUIREMENTS

.1 Section 27 05 26 – Grounding & Bonding for Communications Systems.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.

.2 Copper conductor: minimum 6 m long for each concrete-encased electrode, bare, stranded, tinned, soft annealed, size as required.

.3 Rod electrodes: copper clad steel 19 mm diameter by minimum 3 m long.

.4 Grounding conductors: bare stranded copper, soft annealed, size as required by applicable codes.

.5 Insulated grounding conductors: green, copper conductors, size as required by applicable codes.

.6 Ground bus: copper, size as required, complete with insulated supports, fastenings, connectors.

.7 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
- .1 Grounding and bonding bushings.
- .2 Protective-type clamps.
- .3 Bolted-type conductor connectors.
- .4 Thermit welded-type conductor connectors.
- .5 Bonding jumpers, straps.
- .6 Pressure wire connectors.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other sections or contracts are acceptable for grounding equipment installation in accordance with manufacturer's written instructions:
- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system, including electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.

.2 Install connectors in accordance with manufacturer's instructions.

.3 Protect exposed grounding conductors from mechanical injury.

.4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by Thermit process permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.

.5 Use mechanical connectors for grounding connections to equipment provided with lugs.

.6 Soldered joints not permitted.

.7 Install bonding wire for flexible conduit, connected at both one ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.8 Install separate ground conductor to outdoor lighting standards.

.9 Connect building structural steel and metal siding to ground.

.10 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.11 Bond single-conductor, metallic armoured cables to cabinet at supply end.

.12 Ground secondary service pedestals.

.13 Provide grounding and bonding for systems as per Section 27 05 26 – Grounding & Bonding for Communications Systems. Coordinate requirements as per communications drawings.

3.3 MAINTENANCE HOLES

.1 Install conveniently located grounding stud, electrode, size to suit stranded copper conductor in each maintenance hole.

.2 Install ground rod in each maintenance hole so that top projects through bottom of maintenance hole. Provide with lug to which grounding connection can be made. Confirm ground resistance meets or exceeds Canadian Electrical Code minimum requirements.

3.4 ELECTRODES

.1 Make ground connections to continuously conductive underground water pipe on street side of water meter.

.2 Install water meter shunt.

.3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.

.4 Install rod electrodes and make grounding connections.

.5 Bond separate, multiple electrodes together.

.6 Use size 4/0 AWG copper conductors for connections to electrodes.

3.5 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral of primary system if required in addition to secondary 120/208V system.

3.6 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to, the following list: service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.7 GROUNDING BUS

.1 Install copper grounding bus mounted on insulated supports on wall of electrical room and communication equipment room.

.2 Ground items of existing and new electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections size 2/0 AWG.

3.8 COMMUNICATION SYSTEMS

.1 Install grounding connections for telephone, sound, fire alarm, security systems, intercommunication systems as follows:

.1 Telephones: Make telephone grounding system in accordance with telephone company's requirements.

.2 Sound, fire alarm, security systems, intercommunication systems as indicated.

3.9 FIELD QUALITY CONTROL

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

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

PART 1 - GENERAL

1.1 READED REQUIREMENTS

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

1.2 READED REQUIREMENTS

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging materials in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused metal materials from landfill to metal recycling facility ad approved by Consultant.

.4 Fold up metal banding, flatten, and place in designated area for recycling.

PART 2 - PRODUCTS

2.1 SUPPORT CHANNELS

.1 U-shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Secure equipment to masonry, tile and plaster surfaces with approved anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure surface-mounted equipment with twist-clip fasteners to inverted T-bar ceilings. Ensure that T-bars are adequately supported to carry weight of equipment specified before installation.

.4 Support equipment, conduit or cables using clips, spring-loaded bolts, cable clamps designed as accessories to basic channel members.

.5 Fasten exposed conduit or cables to building construction or support system using straps:
- .1 One-hole malleable iron straps to secure surface conduits and cables 50 mm and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 50 mm.
- .3 Beam clamps to secure conduit to exposed steel work.

.6 Suspended support systems:
- .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
- .2 Support two or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.

.7 For surface mounting of two (2) or more conduits use channels at 1.5 m on centre spacing.

.8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.10 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.

.12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International):
  .1 CSA C22.1-06, Canadian Electrical Code, Part 1, 20th Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
  .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Provide shop drawings: in accordance with Section 01 33 00 – Submittal Procedures:
  .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

PART 2 - PRODUCTS

2.1 SPLITTERS

.1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 Spare Terminals: minimum three (3) spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 JUNCTION AND PULL BOXES

.1 Construction: welded steel enclosure.

.2 Covers Flush Mounted: 25 mm minimum extension all around.

.3 Covers Surface Mounted: screw-on flat covers.

2.3 CABINETS

.1 Construction: welded sheet steel hinged door, handle, latch, lock, two (2) keys and catch.

.2 Type E Empty: surface mounting as indicated.

.3 Type T Terminal: surface mounting containing 19 mm fir plywood backboard.

PART 3 - EXECUTION

3.1 SPLITTER INSTALLATION

.1 Mount plumb, true and square to building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.

.3 Install terminal block as indicated in Type T cabinets.

.4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.3 IDENTIFICATION

.1 Equipment Identification: Refer to Section 26 05 00 – Common Work Results for Electrical.

.2 Identification Labels: Size 2 indicating system name, voltage and phase or as indicated.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International):
.1 CSA C22.1-06, Canadian Electrical Code, Part 1, 20th Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit samples for floor box in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347 V outlet boxes for 347 V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

.7 All fittings used to be manufactured as accessories to the associated raceway and of consistent material, i.e., PVC where PVC conduit is used.

2.2 GALVANIZED STEEL OUTLET BOXES

.1 One-piece electro-galvanized construction.

.2 Single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size: 102 x 54 x 48 mm.

.4 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.5 Extension and plaster rings for flush mounting devices in finished plaster tile walls.

2.3 MASONRY BOXES

.1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

.1 Concrete tight, electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 73 mm for receptacles. Floor boxes to be Thomas & Betts 665-C1 Series.

.2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 21 and 27 mm conduit. Minimum size: 73 mm deep.

2.6 POKE-THROUGH FLOOR OUTLETS

.1 Fire rated poke-through floor boxes to be Thomas & Betts RPT6 Series.

2.7 CONDUIT BOXES

.1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.8 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral-insulated and armoured cable connections. Do not install reducing washers.

.5 Vacuum clean interior of outlet boxes before installation of wiring devices.

.6 Identify systems for outlet boxes as required.

.7 Back to back outlet boxes to be 600 mm apart.

.8 Outlet boxes to be at same height from finished floor level as adjacent electrical duplex receptacles except for television outlets, which are to be placed at 1525 mm above finished floor level, unless otherwise indicated.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

.2 Section 27 05 28 – Pathways for Communications.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International):

.1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.

.2 CSA C22.2 No. 45-M1981 (R2003), Rigid Metal Conduit.

.3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.4 CSA C22.2 No. 83-M1985 (R2003), Electrical Metallic Tubing.

.5 CSA C22.2 No. 211.2-M1984 (R2003), Rigid PVC (Unplasticized) Conduit.

.6 CAN/CSA C22.2 No. 227.3-05, Non-metallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.3 ABBREVIATIONS

.1 "RC" means rigid heavy-wall galvanized steel.

.2 "ERC" means zinc electro-galvanized.

.3 "EMT" means electrical metallic tubing.

.4 "PVC" means rigid PVC conduit.

.5 "FC" means flexible conduit.

.6 "FLC" means flexible liquid tight conduit.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product data: Submit manufacturer's printed product literature, specifications and datasheets:

.1 Submit cable manufacturing data.

.3 Quality assurance submittals:

.1 Test reports: Submit certified test reports.

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

.3 Instructions: Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 CABLES AND REELS

.1 Provide cables on reels or coils:
  .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.

.2 Each coil or reel of cable to contain only one continuous cable without splices.

.3 Identify cables for exclusively dc applications.

.4 Reel and mark shielded cables rated 2,001 volts and above.

2.2 CONDUIT

.1 Rigid-metal conduit: to CSA C22.2 No. 45, galvanized steel.

.2 Epoxy-coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.

.3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.

.4 Rigid PVC conduit: to CSA C22.2 No. 211.2.

.5 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

2.3 CONDUIT FASTENINGS

.1 One-hole malleable iron straps to secure surface conduits 50 mm and smaller.
  .1 Two-hole steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1.5 m on centre.

.4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

.1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.

.2 Ensure factory "ells" where 90 degree bends for 25 mm and larger conduits.

.3 Watertight connectors and couplings shall be used for outdoor applications, in raised floor application, indoor applications where environment requires specific application.

.4 Set screws shall be used for indoor EMT applications.
  .1 Cast fittings are not acceptable.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 FISH CORD

.1 Polypropylene.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Drawings do not show all conduits. Those shown are in diagrammatic form only. Install conduits to conserve headroom in exposed locations and cause minimum interference in the spaces through which they pass.

.2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.3 Use rigid galvanized steel threaded conduit where specified or subject to mechanical injury.

.4 Use electrical metallic tubing (EMT) except in cast concrete, and where not subject to mechanical injury.

.5 Use rigid PVC conduit underground.

.6 Use liquid-tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations, and Connections to kitchen equipment.

.7 Use explosion proof, flexible connection for connection to explosion proof motors.

.8 Install conduit sealing fittings in hazardous areas.
  .1 Fill with compound.

.9 Minimum conduit size for lighting and power circuits: 19 mm.

.10 Bend conduit cold:
  .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.11 Mechanically bend steel conduit over 19 mm diameter.

.12 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.13 Install fish cord in empty conduits.

.14 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel.

.1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in flush concrete type box.

.15 Remove and replace blocked conduit sections.

.1 Do not use liquids to clean out conduits.

.16 Dry conduits out before installing wire.

3.3 SURFACE CONDUIT

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas-fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended channels.

.5 Do not pass conduits through structural members, except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUIT

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section includes:

.1 Materials and installation for line and/or low voltage control system designed to provide remote switching of lighting loads by use of:

.1 Line voltage manual on / off / 0-10v dimmer c/w built-in vacancy sensor wall switches.

.2 Line voltage manual on/off c/w built-in vacancy sensor wall switches.

.3 Low voltage digital manual on / off / 0-10v digital dimming wall switches.

.4 Low voltage digital manual on / off / 0-10v digital tunable white wall switches.

.5 Low voltage manual on / off / 0-10v digital scene control wall switches.

.6 ON / OFF / 0-10v digital dimming enhanced room controllers.

.7 Emergency lighting control device /unit.

.8 Low voltage wall mounted lighting control sensors (Type A and/or Type B).

.9 Low voltage ceiling mounted lighting control sensors (Type C and/or Type D).

.10 Line voltage ceiling mounted lighting control sensors (Type F).

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

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

.2 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures. Indicate VOC content.

.2 Shop Drawings:

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

.2 Retain lighting controls manufacturer to produce and provide detailed wiring diagrams for each custom lighting control system based on the lighting layout drawings E10, E11, E12, lighting controls schedules on drawings E15, E16, E17, E18 and E30.

.3 Detailed wiring diagrams to indicate and identify all devices required (room controllers, switches, sensors, emergency relays), wiring for 120v, 0-10v dimming, 0-10v colour tuning, Cat5e cables connection points, from supply circuit(s) to control devices and luminaire fixture / drivers.

.4 Each diagram to be submitted as part of the lighting control shop drawing package and to be included in operation and maintenance manuals.

.3 Closeout Submittals:

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

.4 Quality Assurance Submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Contractor to retain the services of the manufacturer's authorized service representative to inspect components, assemble and equipment installation, including connectors and to assist in all testing, programming and commissioning of each system. Notify engineer and manufacturers factory authorized representative minimum three (3) weeks prior to system start-up, testing and commissioning.

.2 Manufacturer's service representative shall perform inspections and reports for verification of class 1 and class 2 wiring, verify complete task programming for all switches, dimmers time clocks, sensors and room controllers. Verify that the control of each room/area complies with the sequence of operation, various lighting control of each room/space, and/or various scene control of each room/space.

.3 Correct any system issues and retest systems to meet the room/area control requirements.

.4 Provide written report in table format for each room/space that has manufactures lighting control installed indicating, date if test / inspection, quantity and type of devices installed and device settings for each room/area.

.5 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

.6 Test reports:

.1 Submit certified test reports indicating compliance with specifications for specified performance characteristics and physical properties.

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

.8 Manufacturer's Instructions: submit manufacturer's installation instructions.

.9 Manufacturer's Field Reports: manufacturer's field reports specified

.10 Lighting control system by one manufacturer throughout the project.

.11 Cover plates from one manufacturer throughout the project.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

.1 Materials and products in accordance with Section 01 61 00 – Common Product Requirements.

2.2 MATERIALS

.1 Control system: By one manufacturer and assembled from compatible components.

2.3 LINE VOLTAGE MANUAL ON / OFF / 0-10V DIMMER C/W BUILT-IN VACANCY SENSOR WALL SWITCHES

.1 Duel technology 0-10v dimming wall switch vacancy sensor.

.2 Factory default to Manual ON, Auto OFF.

.3 Operating voltage: 120/277Vac, 50/60Hz.

.4 Field adjustable time delay settings for Auto OFF 3, 5, 15 30 minutes. Time delay to be set at 5 minutes. Additional DIP switch setting built-in to allow user to field adjust additional features such as sensing technology, fade rate, visual or audio alerts.

.5 Vandal resistant colour matched low profile PIR lens.

.6 Duel sensor coverage Passive infrared (PIR) and Ultrasonic:

.1 Major motion PIR 10.6m x 9.1m, Ultrasonic 6.1m x 6.1m

.2 Minor motion PIR 6.1m x 4.5m, Ultrasonic 4.5m x 4.5m

.7 Coloured pre-stripped leads.

.8 ON / OFF , UP / DOWN dimmer buttons.

.9 CUL listed.

.10 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.11 WattStopper Model # DW-311-W colour white.

2.4 LINE VOLTAGE ON/OFF C/W BUILT-IN VACANCY SENSOR WALL SWITCHES

.1 Duel technology ON / OFF wall switch vacancy sensor.

.2 Factory default to Manual ON, Auto OFF.

.3 Operating voltage: 120/277Vac, 50/60Hz.

.4 Dimming control signal 0-10 Volt, sinks up to 50mA for control of compatible ballast, Class 1 wiring.

.5 Field adjustable time delay settings for Auto OFF at 5, 15 30 minutes. Time delay to be set at 5 minutes. Additional DIP switch setting built-in to allow user to field adjust additional features such as sensing technology, visual or audio alerts.

.6 Vandal resistant colour matched low profile PIR lens.

.7 Duel sensor coverage Passive infrared (PIR) and Ultrasonic:

.1 Major motion PIR 10.6m x 9.1m, Ultrasonic 6.1m x 6.1m

.2 Minor motion PIR 6.1m x 4.5m, Ultrasonic 4.5m x 4.5m

.8 Coloured pre-stripped leads.

.9 ON / OFF button.

.10 CUL listed.

.11 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.12 WattStopper Model # DSW-301-W colour white.

2.5 LOW VOLTAGE MANUAL ON / OFF / 0-10V DIGITAL DIMMING WALL SWITCHES

.1 Low voltage ON / OFF / dimming switch for control of dimmable loads via a (DLM) digital lighting management room controllers.

.2 Hidden Push to learn mode configurable button.

.3 Operating voltage: 24Vdc, 5mA, from DLM with two (2) RJ45 ports for DLM network connections.

.4 Control button with LED status indicators. Seven (7) LED Dimming level Indicators.

.5 Built-in infrared (IR) transceiver.

.6 ON / OFF , UP / DOWN one (1) buttons switch.

.7 CUL listed.

.8 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.9 Switch to be engraved with to read “DIMMER” c/w up and down arrows.

.10 WattStopper Model # LMDM-101-W colour white.

2.6 LOW VOLTAGE MANUAL ON / OFF / 0-10V DIGITAL TUNABLE WHITE WALL SWITCHES

.1 Low voltage ON / OFF / dimming switch for control of dimmable loads via a (DLM) digital lighting management room controllers.

.2 Hidden Push to learn mode configurable button.

.3 Operating voltage: 24Vdc, 5mA from DLM with two (2) RJ45 ports for DLM network connections.

.4 Control button with LED status indicators. Seven (7) LED Dimming level Indicators.

.5 Built-in infrared (IR) transceiver.

.6 ON / OFF , UP / DOWN one (1) buttons switch.

.7 CUL listed.

.8 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.9 Switch to be engraved with to read “COLOUR TUNING” c/w up and down arrows.

.10 WattStopper Model # LMDM-101-G colour grey.

2.7 LOW VOLTAGE MANUAL ON / OFF / 0-10V DIGITAL SCENE CONTROL WALL SWITCHES

.1 Low voltage ON / OFF / dimming switch for control of dimmable loads via a (DLM) digital lighting management room controllers.

.2 Hidden Push to learn mode configurable button.

.3 Operating voltage: 24Vdc, 5mA from DLM with two (2) RJ45 ports for DLM network connections.

.4 Control buttons with LED status indicators.

.5 Built-in infrared (IR) transceiver.

.6 Four (4) scene ON / OFF buttons, one (1) UP / DOWN dimmer buttons switch.

.7 CUL listed.

.8 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.9 Switches to be engraved with to read “SCENE 1”, “SCENE 2”, “SCENE 3”, “SCENE 4” c/w up and down arrows engraved on dimmer button.

.10 WattStopper Model # LMSW-105-W colour white.

2.8 ON / OFF / 0-10V DIGITAL DIMMING ENHANCED ROOM CONTROLLERS

.1 Plenum rated controller, (DLM) digital lighting management room controllers with line voltage relays and 0-10v dimming outputs for luminaire dimming and/or luminaire (CCT) correlated colour tuning.

.2 Operating voltage: 120/277Vac, 50/60Hz, rated for 20A total load.

.3 Built-in real time monitoring.

.4 ON / OFF 0-10 volt room controllers: LMRC-211, One (1), LMRC-212, two (2) and LMRC-213, three (3), relay configurations c/w similar 0-10 volt dimming output.

.5 Relays for dimming control and/or (CCT) Correlated Colour Temperature tuning.

.6 Smart 250mA switching power supply.

.7 Four (4) RJ45 DLM local network ports with integral strain relief.

.8 One (1) dimming output per relay. 0-10v for control of compatible ballast and/or LED drivers. 0-10v output shall automatically open upon loss of power to room controller to assure full lighting output from controlled lighting.

.9 Plug and go automatic configuration, Store load pre-set level and 16 scene pre-set levels for each load.

.10 Connection to other components using (LMRJ cables) CAT5E cables with RJ-45 jacks, Line voltage and class 2 0-10v control wiring.

.11 Mount to standard 100 x 100 x 54mm square junction box within accessible ceiling space.

.12 CUL listed.

.13 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.14 WattStopper Model # LMRC-212 two (2) relay, LMRC-213 three (3) relay.

.15 Contractor shall provide all necessary components outlet boxes, junction box conduit systems, wall switches, sensors, emergency control devices/units, 120vac power wiring, 0-10v control wiring and LMRJ cables for all devices to provide an acceptable controllable complete and operational lighting system.

.16 It shall be the contractor's responsibility to make all proper adjustments to assure owner's satisfaction with each area/space lighting control system. Refer to lighting schematics on drawings for various types of connections and conditions lighting control.

2.9 EMERGENCY LIGHTING CONTROL DEVICE / UNIT

.1 Plenum rated emergency control unit that monitors a single circuit that provides normal lighting to an area/space. When normal power is present the control unit to permit other lighting control devices (e.g., switches, sensors, room controllers to control the emergency lighting fixtures with the general normal circuit lighting fixtures. Where normal power is lost the control unit will force ON the emergency lighting fixtures. Refer to lighting schematics on drawings for various types of connections and conditions of emergency lighting control.

.2 Operating voltage: 120/277Vac, 50/60Hz, rated for 20A total load.

.3 Maximum load: ballast 20A, incandescent 10A, and motor 1HP.

.4 Operates as a control device or as a shunt. Compatible with wiring and controls for Digital room controllers.

.5 Built-in Push to test button on unit to activate emergency mode for test conditions. Provides fail to on emergency lighting.

.6 LED indication lights for emergency and normal power.

.7 Connection to other components using (LMRJ cables) CAT5E cables with RJ-45 jacks, Line voltage and class 2 0-10v control wiring.

.8 Threaded nipple for mounting to junction box within accessible ceiling space.

.9 CUL listed.

.10 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.11 WattStopper Model # ELCU-200

2.10 LOW VOLTAGE WALL MOUNTED LIGHTING CONTROL SENSORS

.1 Dual technology wall mount occupancy and/or vacancy sensor with both passive infrared (PIR) and ultrasonic technology to achieve precise and energy efficient sensing for lighting loads.

.2 Compatible with the digital lighting management (DLM) system for each area/space to be controlled.

.3 Wall Sensors:

.1 Sensor shall not require any manual adjustment after initial configuration / programming of sensor to suit operation of room. Sensor to be configured /Programmed as either Type A Vacancy sensor (Manual ON via room controller and peripheral switch devices with adjustable time delay AUTO OFF) or as Type B Occupancy Sensor (Auto ON / with adjustable time delay Auto OFF).

.2 Sensor to be c/w Push and learn functionality for customization without the need for tools or a PC.

.3 Sensor detection signature processing eliminates false triggers and provides immunity to RFI and EMI interference.

.4 Sensor infrared (IR) Transceiver for wireless configuration and remote control.

.5 Sensor shall utilize both passive infrared and ultrasonic technology to detect motion.

.6 Sensor operating voltage: 24Vdc, 20mA from DLM with either (1) or two (2) RJ45 ports for DLM network connections as required.

.7 Sensor shall incorporate a Fresnel lens.

.8 Sensor shall be provided with a variety of mask inserts for PIR rejection to prevent false tripping.

.9 Duel sensor coverage Passive infrared (PIR) and Ultrasonic:

.1 Major motion PIR 13.7m, Ultrasonic 8.5m & 3.0m above floor mounting height.

.10 Sensor shall have manual controls and override switches to force manual adjustments.

.11 Sensor shall have time delay that can be adjusted manually from 1 to 30 minutes. Time delay to be initially set at 5 minutes unless indicated or noted otherwise.

.12 Sensor sensitivity shall be adjustable from 10% to 100%, 10% increments.

.13 Sensor shall have controls behind a cover to resist tampering. All controls shall be accessible from the front of the sensor.

.14 Sensor LCD display c/w pushbuttons for setting and/or adjusting sensor and system parameters.

.15 Sensor shall be wall mounted to flush 100mm square device outlet box suitable for sensor mounting plate.

.16 Sensor shall accept LMRJ cables.

.17 Sensor shall be white in colour.

.18 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.19 CUL listed.

.20 WattStopper Model # LMDX-100.

.4 Refer to drawings (Type A to be set / programmed as Vacancy sensor) and (Type B to be set / programmed as Occupancy sensor).

2.11 LOW VOLTAGE CEILING MOUNTED LIGHTING CONTROL SENSORS

.1 Dual technology ceiling mount occupancy and/or vacancy sensor with both passive infrared (PIR) and ultrasonic technology to achieve precise and energy efficient sensing for lighting loads.

.2 Compatible with the digital lighting management (DLM) system for each area/space to be controlled.

.3 Wall Sensors:

.1 Sensor shall not require any manual adjustment after initial configuration / programming of sensor to suit operation of room. Sensor to be configured /Programmed as either Type C Vacancy sensor (Manual ON via room controller and peripheral switch devices with adjustable time delay AUTO OFF) or as Type D Occupancy Sensor (Auto ON / with adjustable time delay Auto OFF).

.2 Sensor to be c/w Push and learn functionality for customization without the need for tools or a PC.

.3 Sensor detection signature processing eliminates false triggers and provides immunity to RFI and EMI interference.

.4 Sensor infrared (IR) Transceiver for wireless configuration and remote control.

.5 Sensor shall utilize both passive infrared and ultrasonic technology to detect motion.

.6 Sensor operating voltage: 24Vdc, 20mA from DLM with either (1) or two (2) RJ45 ports for DLM network connections as required.

.7 Sensor shall incorporate a Fresnel lens.

.8 Sensor shall be provided with a variety of mask inserts for PIR rejection to prevent false tripping.

.9 Duel sensor coverage Passive infrared (PIR) and Ultrasonic:

.1 Major motion PIR 9.7m, Ultrasonic 7.6m & 3.0m above floor mounting height.

.10 Sensor shall have manual controls and override switches to force manual adjustments.

.11 Sensor shall have time delay that can be adjusted manually from 1 to 30 minutes. Time delay to be initially set at 5 minutes unless indicated or noted otherwise.

.12 Sensor sensitivity shall be adjustable from 10% to 100%, 10% increments.

.13 Sensor shall have controls behind a cover to resist tampering. All controls shall be accessible from the front of the sensor.

.14 Sensor LCD display c/w pushbuttons for setting and/or adjusting sensor and system parameters.

.15 Sensor shall be wall mounted to flush 100mm octagonal deep device outlet box suitable for sensor mounting.

.16 Sensor shall accept LMRJ cables.

.17 Sensor shall be white in colour.

.18 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.19 CUL listed.

.20 WattStopper Model # LMDC-100.

.4 Refer to drawings (Type C to be set / programmed as Vacancy sensor) and (Type D to be set / programmed as Occupancy sensor).

2.12 LINE VOLTAGE CEILING MOUNTED LIGHTING CONTROL SENSORS

.1 Dual technology line voltage ceiling mount occupancy and/or vacancy sensor with both passive infrared (PIR) and ultrasonic technology to achieve precise and energy efficient sensing for lighting loads.

.2 Compatible with the digital lighting management (DLM) system for each area/space to be controlled.

.3 Wall Sensors:

.1 Sensor shall not require any manual adjustment after initial configuration / programming of sensor to suit operation of room. Sensor to be configured /Programmed as Type F Occupancy Sensor (Auto ON / with adjustable time delay Auto OFF)

.2 Sensor detection signature processing eliminates false triggers and provides immunity to RFI and EMI interference.

.3 Sensor infrared (IR) Transceiver for wireless configuration and remote control.

.4 Sensor shall utilize both passive infrared and ultrasonic technology to detect motion.

.5 Sensor operating voltage: 120/230Vac, 50/60Hz. Uses line voltage and does not require a power pack.

.6 Sensor shall incorporate a Fresnel lens.

.7 Sensor shall be provided with a variety of mask inserts for PIR rejection to prevent false tripping.

.8 . Duel sensor coverage Passive infrared (PIR) and Ultrasonic:

.1 Major motion PIR 10.9m, Ultrasonic 10.9m & 3.0m above floor mounting height.

.9 Sensor shall have manual controls and override switches to force manual adjustments.

.10 Sensor shall have time delay that can be adjusted manually from 5, 10, 15, 20 or 30 minutes. Time delay to be initially set at 5 minutes unless indicated or noted otherwise.

.11 Sensor sensitivity shall be adjustable in 10% increments.

.12 Sensor shall have controls behind a cover to resist tampering. All controls shall be accessible from the front of the sensor.

.13 Sensor shall have built-in DIP switches for adjusting sensor and system parameters.

.14 Sensor shall be wall mounted to flush 100mm octagonal deep device outlet box suitable for sensor mounting c/w CA-1 adapter ring plate.

.15 Sensor shall be white in colour.

.16 Manufacture to provide minimum five (5) year warranty on product within the installation unless otherwise noted, and consisting of a one (1) to one (1) device replacement.

.17 CUL listed.

.18 WattStopper Model # DT-355 c/w CA-1.

.19 Refer to drawings (Type f to be set / programmed as Occupancy sensor).

.20 Contractor shall provide all necessary components outlet boxes, junction box conduit systems, sensors, 120vac power wiring, lighting control relays as required to provide an acceptable controllable complete and operational lighting system.

.21 It shall be the contractor's responsibility to make all proper adjustments to assure owner's satisfaction with each area/space lighting control system. Refer to lighting schematics on drawings for various types of connections and conditions lighting control.

2.13 PRETERMINATED DLM CABLES

.1 Contractor shall provide LMRJ segment network control cables, supplied and tested by the lighting control manufacturer with pre-terminated Cat5e green plenum rated control wiring c/w industry standard RJ-45 connectors compatible with any RJ-45 port on the manufacturer's DLM components.

.2 Contractor to coordinate on site and determine lengths of cable(s) required to suit installation and manufactures requirements.

.3 Non-plenum rated pre-terminated jumper cables may be used between devices to be mounted in multi-ganged device outlet boxes.

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.

.2 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

3.2 INSTALLATION

.1 Install system in accordance with the approved system shop drawings and manufacturer's instructions.

.2 Install all room/area devices using manufacturer's factory tested Cat5e cables with pre-terminated RJ-45 connectors.

.3 All line voltage connectors shall be tagged to indicate circuit and switched legs.

.4 Calibrate all sensor time delays and sensitivity of all occupancy and/or vacancy devices to guarantee proper detection of occupancy and energy savings.

.5 Test all devices and installed systems in rooms/area's to ensure proper communication.

.6 Provide separate dedicated neutral for any phase dimming and colour tuning branch lighting load circuit.

.7 All class 2 cabling shall enter enclosures from within low voltage wiring areas and shall remain with those areas. No class 1 conductors shall enter a low voltage area.

.8 All low voltage wiring to comply with manufacturer's requirements / specifications.

.9 Verify all lighting loads to be free from short circuits prior to connection to room controllers.

.10 All Cat5e DLM control system wiring to be routed through walls from wall mounted devices and/or in gypsum board ceilings shall be installed in min. 21mm EMT conduit systems with nylon bushing free of burrs from device to accessible ceiling space.

.11 Locate and install equipment in accordance with manufacturer's recommendations to meet the intent of the lighting control design.

.12 Provide all necessary components outlet boxes, junction box conduit systems, wall switches, sensors, emergency control devices/units, 120vac power wiring, plenum rated 0-10v control wiring and LMRJ cables for all devices to provide an acceptable controllable complete and operational lighting system. Non-plenum rated network cable maybe used between ganged device wall switches or where cables are routed in enclosed device boxes with conduit systems.

.13 Aim all sensors in the correct locations to ensure complete and proper volumetric coverage within the range of the sensor coverage or controlled area as per the manufacturer's recommendations. Each room/area shall have 90% to 100% coverage to completely control the space accommodating all occupancy habits of either single or multiple user/occupants at any location within the space.

.14 Sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.

.15 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitation or interference of structural components.

.16 Make all proper adjustments to assure owner's satisfaction with each area/room lighting control system. Refer to lighting schematics on drawings for various types of lighting controls for areas/rooms.

.17 Install suitable common cover plates where wiring devices are grouped.

.18 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.19 Make all proper adjustments to assure owner's satisfaction with each area/room lighting control system. Refer to lighting schematics on drawings for various types of lighting controls for areas/rooms

.20 Protect installed products and components from damage during construction.

.21 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.22 Repair damage to adjacent materials caused by wiring device installation.

3.3 COMMISSIONING

.1 Contractor to retain the lighting controls manufacturer service representative / technician to perform on site all acceptance testing, system/device programming for each room/area to be controlled. Contractor to arrange and notify Building owners representative, engineer and manufacturers factory authorized representative minimum three (3) weeks prior to system start-up, testing and commissioning.

.2 Provide to building owner’s personnel, Wireless configuration tool LMCT-100 c/w all necessary training.

.3 Contractor shall also provide at the owner’s facility, the training necessary to familiarize the owner’s personnel with the operation, use, adjustment, and problem solving diagnosis of the lighting control systems, wall mounted device switches, occupancy sensing devices.

3.4 FIELD QUALITY CONTROL

.1 Site Tests:

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

.2 Actuate control units in presence of Consultant to demonstrate lighting circuits are controlled as designated.

.2 Manufacturer's Field Services:

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

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

.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

.3 Verification requirements include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

.1 CSA International:

.1 CAN/CSA-C22.2 No.47-M90 (R2007), Air-Cooled Transformers (Dry Type).

.2 CSA C9-02 (R2007), Dry-Type Transformers.

.3 CAN/CSA-C802.2-06, Minimum Efficiency Values for Dry Type Transformers.

.2 National Electrical Manufacturers Association (NEMA).

1.3 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 dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: Submit operation and maintenance data for dry type transformers for incorporation into manual.

PART 2 - PRODUCTS

2.1 DESIGN DESCRIPTION

.1 Performance Characteristics.

.1 Type: ANN

.2 Single or three phase, kVA as indicated, V input as indicated, V output as indicated, 60 Hz.

.3 Voltage taps: standard.

.4 Insulation: Class H, 105 degrees C temperature rise.

.5 Basic Impulse Level (BIL): standard.

.6 Hi-pot: standard.

.7 Average sound level: standard

.8 Impedance at 17 degrees C: between 5% and 6%

.9 Enclosure: CSA, removable metal front panel. Provide NEMA 3RI enclosure for transformers in garage area.

.10 Mounting: floor, wall, or suspended as indicated.

.11 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.

.12 Copper windings.

.13 Winding configuration to be three (3) phase, four (4) wire, star-delta.

.14 K-rated Transformers as indicated on drawings.

.15 Voltage Regulation to be 4% or better.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Label size: 7.

.3 Nameplate wording: to be determined upon shop drawing review.

2.3 APPROVED MANUFACTURERS

.1 Delta.

.2 Hammond.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for dry type transformers installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Mount dry type transformers up to 75 kVA as indicated.

.2 Ensure adequate clearance around transformer for ventilation.

.3 Install transformers in level upright position.

.4 Remove shipping supports only after transformer is installed and just before putting into service.

.5 Loosen isolation pad bolts until no compression is visible.

.6 Make primary and secondary connections in accordance with wiring diagram using flexible conduit connections.

.7 Energize transformers after installation is complete.

.8 Make conduit entry into bottom 1/3 of transformer enclosure.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.

.2 Leave Work area clean at end of each day.

.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by dry type transformers installation.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

.1 CSA International:
- .1 CSA C22.2 No.29-11, Panel boards and Enclosed Panel boards.

1.3 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 panel boards and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
- .1 Include on drawings:
  - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: Submit operation and maintenance data for panel boards for incorporation into manual.

PART 2 - PRODUCTS

2.1 PANEL BOARDS

.1 Panel Boards: to CSA C22.2 No.29 and product of one manufacturer.
- .1 Install circuit breakers in panel boards before shipment.
- .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 208 V and 600 V Panel Boards: bus and breakers rated for symmetrical interrupting capacity as indicated on drawings.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panel Boards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Minimum of two (2) flush locks for each panel board.

.6 Two (2) keys for each panel board and key panel boards alike.

.7 Copper or Aluminum bus with neutral of same ampere rating of mains.

.8 Mains: suitable for bolt-on breakers.

.9 Trim with concealed front bolts and hinges.

.10 Trim and Door Finish: baked enamel.

2.2 BREAKERS

.1 Breakers: as indicated on drawings.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main Breaker: as indicated on drawings and separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for 15 % of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to Consultant.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results for Electrical.

.2 Nameplate for each panel board size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panel boards Size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

2.4 APPROVED MANUFACTURERS

.1 Eaton.

.2 Schneider.

.3 Siemens.

PART 3 - EXECUTION

3.1 EXAMINATION

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

- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Locate panel boards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Mount panel boards to height specified in Section 26 05 00 - Common Work Results for Electrical or as indicated.

.3 Connect loads to circuits.

.4 Connect neutral conductors to common neutral bus with respective neutral identified.

.5 Coordinate with Equipment Manufacturer to provide / retrofit existing Switchboard BP-2 with new panel as detailed on single line drawing. Coordinate shutdown for retrofit and connect new and existing feeders to new panel boards.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by panelboards installation.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 CSA International:
- .1 CAN/CSA C22.2 No.94.1-07, Enclosures for Electrical Equipment, Non Environment Considerations.

.2 National Electrical Manufacturers Association (NEMA):
- .1 NEMA 250-2008, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Shop Drawings:
- .1 Submit manufacturer's instructions, printed product literature and data sheets for electrical cabinets and enclosures and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and maintenance data: Submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish, size as indicated.

.2 Entire enclosure to be capable of withstanding maximum impact force of 86 MN/m^2 area without rupture of material.

.3 Removable enclosure panels with formed edges galvanized steel external fasteners removable only from inside enclosure.

.4 Equip enclosure with hot dipped galvanized mounting rails to enable mounting of equipment at any location within housing.

.5 Door: 3 point latching, with padlocking means.

.6 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wildlife, and vermin.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical cabinet and enclosure installation in accordance with manufacturer's written instructions:

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.

.2 Mount equipment in enclosure.

.3 Label electrical cabinets and enclosure to Section 26 05 00 – Common Work Results for Electrical.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 CSA International:
- .1 CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
- .2 CAN/CSA C22.2 No.42.1-00 (R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
- .3 CSA C22.2 No.55-M1986 (R2008), Special Use Switches.
- .4 CSA C22.2 No.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Shop Drawings:
- .1 Submit manufacturer's instructions, printed product literature and data sheets for wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: Submit operation and maintenance data for wiring devices for incorporation into manual.

PART 2 - PRODUCTS

2.1 SWITCHES

.1 Single-pole, double-pole, three-way, or four-way switches to: CSA C22.2 No.55and CSA C22.2 No.111.

.2 Manually-operated general purpose AC switches with following features:
- .1 Terminal holes approved for No. 10 AWG wire.
- .2 Silver alloy contacts.
- .3 Urea or melamine moulding for parts subject to carbon tracking.
- .4 Suitable for back and side wiring.
- .5 Ivory toggle.

.3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 85% of rated capacity branch circuit loads.

.4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

.1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
- .1 Ivory urea moulded housing.
- .2 Suitable for No. 10 AWG for back and side wiring.
- .3 Break-off links for use as split receptacles.
- .4 Eight back wired entrances, four side wiring screws.
- .5 Triple wipe contacts and riveted grounding contacts.

.2 Single receptacles CSA Type 5-15 R, 125 V, 15 A, U ground with following features:
- .1 Ivory urea moulded housing.
- .2 Suitable for No. 10 AWG for back and side wiring.

.3 Four (4) back wired entrances, 2 side wiring screws, other receptacles with ampacity and voltage as indicated.

.4 GFCI receptacles as indicated on drawings, per Section 26 28 20 – Ground Fault Circuit Interrupters – Class A.

.5 Receptacles of one manufacturer throughout project.

2.3 COVER PLATES

.1 Cover plates for wiring devices to: CSA C22.2 No.42.1.

.2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.3 Stainless steel, 1 mm thick cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.

.4 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.5 Weatherproof double-lift, spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.6 Weatherproof spring-loaded cover plates complete with gaskets for single receptacles or switches.

2.4 SOURCE QUALITY CONTROL

.1 Cover plates from one manufacturer throughout project.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Switches:

- .1 Install single throw switches with handle in "UP" position when switch closed.
- .2 Install switches in gang-type outlet box when more than one switch is required in one location.
- .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical, or as indicated.

.2 Receptacles:

- .1 Install receptacles in gang-type outlet box when more than one receptacle is required in one location.
- .2 Mount receptacles at height in accordance with Section 26 05 00 – Common Work Results for Electrical as indicated.
- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .4 Install GFI type receptacles as indicated.

.3 Cover Plates:

- .1 Install suitable common cover plates where wiring devices are grouped.
- .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.3 Repair damage to adjacent materials caused by wiring device installation.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.
- .2 CSA C22.2 No.39-M89 (R2003), Fuse holder Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

.1 Fusible or non-fusible, horsepower-rated disconnect switch in CSA enclosure to CAN/CSA C22.2 No.4, size as indicated.

.2 Provision for padlocking in on-off switch position.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Quick-make, quick-break action.

.5 ON-OFF switch position indication on switch enclosure cover.

.6 For elevator applications provide disconnects with auxiliary contacts (micro switch) for controls.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Indicate name of load controlled on size 4 nameplate.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 CSA International:
.1 CSA C22.2 No.14-10, Industrial Control Equipment.

.2 National Electrical Manufacturers Association (NEMA):
.1 NEMA ICS 1-2000(R2008), Industrial Control and Systems: General Requirements.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 – Submittal Procedures.

.2 Shop Drawings:

.1 Submit manufacturer's instructions, printed product literature and data sheets for control devices and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Include schematic, wiring, interconnection diagrams.

1.3 QUALITY ASSURANCE

.1 Conduct tests in accordance with Section 26 05 00 – Common Work Results for Electrical.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: Submit operation and maintenance data for control devices for incorporation into manual.

PART 2 - PRODUCTS

2.1 AC CONTROL RELAYS

.1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.

.2 Convertible Contact Type: Contacts field convertible from NO to NC, electrically held. Coil and contact rating to suit circuit.

.3 Universal Pole Type: electrically held with 2 DPDT poles, convertible from NO to NC by changing wiring connections. Coil rating and contact rating to suit circuit.

2.2 RELAY ACCESSORIES

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

2.3 SEALED CONTACT OIL TIGHT LIMIT SWITCHES

.1 Lever type switches: roller operated, single pole, double throw. Contact rating to suit circuit.

2.4 OPERATOR CONTROL STATIONS

.1 Enclosure: CSA Type 4, surface mounting:

2.5 PUSHBUTTONS

.1 Heavy duty Oil tight. Operator extend type. Black, with 1-NO and 1-NC contacts sized to suit circuit, labels as indicated. Stop pushbuttons coloured red, provision for padlocking in depressed position.

2.6 SELECTOR SWITCHES

.1 Maintained, 2 or 3 position, heavy duty oil tight, operators standard wing lever, sized to suit circuit.

2.7 INDICATING LIGHTS

.1 Heavy-duty Oil-tight, full voltage, LED type, push-to-test, lens colour: as per shop drawing review, supply voltage: to suit circuit, labels as indicated.

2.8 CONTROL AND RELAY PANELS

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

2.9 CONTROL CIRCUIT TRANSFORMERS

.1 Single phase, dry type.

.2 Primary: 208 through 600 V as required, 60 Hz ac.

.3 Secondary: 120 V, ac.

.4 Rating: 150 VA minimum. Size to suit circuit plus 20%.

.5 Secondary Fuse to suit.

.6 Close voltage regulation as required by magnet coils and solenoid valves.

2.10 THERMOSTAT (LINE VOLTAGE)

.1 Wall mounted, for motor rated exhaust fan control.

.2 Full Load Rating: to suit load requirements.

.3 Temperature Setting Range: 0 degrees C to40 degrees C.

.4 Thermometer Range: -5degrees C to 45 degrees C.

.5 Markings in 5 degree increments.

PART 3 - EXECUTION

3.1 EXAMINATION

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

- .1 Visually inspect substrate.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Install pushbutton stations, control and relay panels, control devices and interconnections.

3.3 FIELD QUALITY CONTROL

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

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 International Electrotechnical Commission (IEC):
  .1 IEC 947-4-1-2002, Part 4: Electromechanical contactors and motor-starters.

.2 Motor Starter Control List.

.3 Refer to individual mechanical specification sections for equipment requirements.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

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

.3 Shop Drawings:
  .1 Provide shop drawings: in accordance with Section 01 33 00 – Submittal Procedures.
  .2 Provide shop drawings for each type of starter to indicate:
    .1 Mounting method and dimensions.
    .2 Starter size and type.
    .3 Layout and components.
    .4 Enclosure types.
    .5 Wiring diagram.
    .6 Interconnection diagrams.

1.3 CLOSEOUT SUBMITTALS

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

.2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.

.3 Extra Materials:
  .1 Provide listed spare parts for each different size and type of starter.
    .1 Contacts, stationary.
    .2 Contacts, movable.
    .3 Contacts, auxiliary.
    .4 Control transformers.
    .5 Operating coil.
    .6 Fuses.
    .7 10% indicating lamp bulbs used.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 MANUAL MOTOR STARTERS

.1 Single or three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

- .1 Switching mechanism, quick make and break.
- .2 Overloads, manual reset, trip indicating handle.
- .3 NEMA 1 enclosure, or as indicated.

.2 Accessories:

- .1 Toggle Local-Off Remote Switch, heavy duty, oil tight, labelled as reviewed on shop drawings.
- .2 Indicating light: heavy duty, oil tight LED type and colour as reviewed on shop drawings.
- .3 Locking tab to permit padlocking in “ON” or “OFF” position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

.1 Combination magnetic starters of size, type, rating, and enclosure type as indicated with components as follows:

- .1 Contactor solenoid operated, rapid action type.
- .2 Motor overload protective device in each phase, manually reset from outside enclosure.
- .3 Wiring and schematic diagram inside starter enclosure in visible location.
- .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .5 NEMA 1 enclosure, or as indicated.

.2 Combination type starters to include fused circuit breaker with operating lever on outside of enclosure to control circuit breaker, and provision for:

- .1 Locking in “OFF” position.
- .2 Independent locking of enclosure door.
- .3 Provision for preventing switching to “ON” position while enclosure door open.

.3 Accessories:

- .1 Toggle Local-Off-Remote Switch, heavy duty, oil tight, labelled as reviewed on shop drawings.
- .2 Indicating light: heavy duty, oil tight LED type and colour as reviewed on shop drawings.
- .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 FRACTIONAL HORSEPOWER LOAD STARTERS

.1 Provide starter for double voltage relay in enclosure for control wiring interface complete with toggle switch for equipment and starter isolation.

2.5 CONTROL TRANSFORMER

.1 Single-phase, dry-type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.6 ACCESSORIES

.1 Pushbutton: heavy duty, oil tight as required.

.2 Selector switches: heavy duty, oil tight as required.

.3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.7 FINISHES

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

2.8 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install starters and control devices in accordance with manufacturer's instructions.

.2 Install and wire starters and controls as indicated.

.3 Ensure correct fuses installed.

.4 Confirm motor nameplate and adjust overload device to suit.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.

.2 Operate switches and contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

3.3 CLEANING

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

.2 Remove surplus materials, excess materials, rubbish, tools, and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation for automatic load transfer equipment which can monitor voltage on all phases of normal power supply, initiate cranking of standby generator unit, transfer loads and shut down standby unit.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN3-C13-M83-Latest Edition, Instrument Transformers.

.2 CSA C22.2 No.5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

.3 CSA C22.2 No.178-1978-Latest Edition, Automatic Transfer Switches.

.2 American National Standards Institute (ANSI)/National Electrical Manufacturers Association (NEMA)

.1 ANSI/NEMA ICS 2-Latest Edition, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

1.3 SYSTEM DESCRIPTION

.1 Automatic load transfer equipment to:

.1 Monitor voltage on phases of normal power supply.

.2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.

.3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.

.4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.

.5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 34 00 – Submittals.

.2 Include:

.1 Make, model and type.

.2 Single line diagram showing controls and relays.

.3 Description of equipment operation including:

.1 Automatic starting and transfer to standby unit and back to normal power.

.2 Test control.

.3 Manual control.

.4 Automatic shutdown.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

.2 Detailed instructions to permit effective operation, maintenance and repair.

.3 Technical data:

.1 Schematic diagram of components, controls and relays.

.2 Illustrated parts lists with parts catalogue numbers.

.3 Certified copy of factory test results.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Consultant.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Instrument transformers: to CAN3-C13.

2.2 AUTOMATIC TRANSFER SWITCH

.1 Provide automatic transfer switch fully rated for resistive or inductive loads as noted on drawings. 347,600 V AC, 60 Hz, for use on a 3-phase, 4-wire system. Build to CASA-C22.2, No. 178-1978.

.2 Provide the following transfer switches

.1 200A, 347,600V 3-pole transfer switch (ATS-LS).

.2 200A, 347,600V 3-pole transfer switch (ATS-NLS).

Transfer switch to be capable of withstanding 35,000 amperes or 25,000 amperes RMS symmetrical fault current(as indicated on drawings), without contact separation or contact welding. Main transfer contact to be protected by an approved arc disruption means, including separate arcing contacts. Operating time in either direction not to exceed one-sixth of a second. Switch to be capable of intercepting six times rated current at a power factor of 0.40 to 0.50. Test to be 50 cycles of operation at a rate of one operation per two minutes.

.3 Transfer switch to be electrically operated, mechanically held. Obtain control and transfer power from source to which it is being transferred. Transfer switch to be operated by single solenoid mechanism so constructed that a neutral position is not possible under electrical operation and shall not have overlapping neutrals.

2.3 CONTROLS

.1 Provide voltage sensing relays for full phase failure protection to initiate transfer of load to emergency power supply when voltage of normal supply drops to 70% on any phase and retransfer it to normal when that supply is restored to 90% on all phases.

.2 Provide relay to prevent transfer to emergency source until frequency and voltage reach preset value.

.3 All components and accessories to be front removable.

.4 Provide one set of SPDT contacts on both normal and emergency supply breakers.

.5 Provide four sets of NC contacts to open when switch operates in the emergency mode to drop out equipment not required on emergency.

.6 Provide one set of NO contacts to close on loss of normal power for future wiring to elevator control panel and one spare NO contact.

.7 Switch to include pilot lights to indicate whether switch is in “normal” or in “emergency” position.

.8 Switch to include maintained test switch to simulate power failure.

.9 An “in-phase” monitor to compare normal source voltage and frequency to generator voltage and frequency. Monitor to signal transfer switch to operate at an advance angle as determined by frequency difference between sources at time of transfer. Automatically adjust phase advance angle at which transfer operation is initiated to permit load to be reconnected, so that inrush currents are limited to not more than normal starting currents. Monitor to control transfer so that motor load inrush currents do not exceed normal starting currents and do not require external control of power sources. In-phase monitor to be specifically designed for and to be the product of the ATS manufacturer.

.10 Transfer switch to include full capacity neutral contacts.

.11 Selector switch – four position “Test”, “Auto”, “Manual”, “Engine Start”.

.1 Test position – Normal power failure simulated. Engine starts and transfer takes place. Return switch to “Auto” to stop engine.

.2 Auto position – Normal operation of transfer switch on failure of normal power; transfer on return of normal voltage and shuts down engine.

.12 Control transformers: dry type with 120 V secondary to isolate control circuits from:

.1 Normal power supply.

.2 Emergency power supply.

.13 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:

.1 Frequency sensing to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.

.14 Microprocessor Controller:

.1 Controller's sensing and logic will be provided by a single built-in microprocessor for maximum reliability, minimum maintenance and the ability to communicate serially through an optional serial communication module.

.2 Single controller to provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing to be true RMS type and to be accurate to +1% of nominal voltage. Frequency sensing to be accurate to +.2%. Panel to be capable of operating over a temperature range of -20 to 60ºC and storage from -55 to +85ºC.

.3 Controller to be connected to the transfer switch by an interconnecting wiring harness. Harness to include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic to be provided on multi-layer printed circuit boards. Interfacing relays to be industrial grade plug-in type with dust covers. Panel to be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. Protective cover to be mounted separately from the transfer switch unit for safety and ease of maintenance. Protective cover to include a built-in pocket for storage of the operator's manuals.

.4 All customer connections to be wired to a common terminal to simplify wiring connections.

.15 Time Delays:

.1 An adjustable time delay of 0 to 6 seconds to be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability to be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

.2 A time delay will be provided on transfer to emergency, adjustable from 0 to 60 minutes for controlled timing of loads to emergency.

.3 Two time delay modes (which are independently adjustable) to be provided on retransfer to normal. One time delay to be for actual normal power failures and the other for the test mode function. Time delays to be adjustable from 0 to 60 minutes. Time delay to be automatically bypassed if the emergency source fails and the normal source is acceptable.

.4 A time delay will be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

.5 A time delay activated output signal will also be provided to drive an external relay(s) for selective load disconnect control. Controller to have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:

.1 Prior to transfer only.

.2 Prior to and after transfer.

.3 Normal to emergency only.

.4 Emergency to normal only.

.5 Normal to emergency and emergency to normal.

.6 All transfer conditions or only when both sources are available.

.6 All time delays will be adjustable in one second increments, except the extended parallel time, which will be adjustable in 0.1 second increments.

.7 All time delays will be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

.16 Additional Features:

.1 A three position momentary-type test switch to be part of the test/automatic/reset modes. The test position will simulate a normal source failure. The reset position will bypass the time delays on either transfer to emergency or retransfer to normal.

.2 A SPDT contact, rated 5 amps at 30 VDC, will be provided for a low voltage engine start signal. The start signal will prevent dry cranking of the engine by requiring the generator set to reach proper output and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

.3 Auxiliary contacts, rated 10 amps, 250 VAC to be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.

.4 LED indicating lights (16 mm industrial grade, Type 12) to be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).

.5 LED indicating lights (16 mm industrial grade, Type 12) to be provided and energized by controller outputs. Lights to provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

.6 The following features to be built-in to the controller but capable of being activated through keypad programming or the serial port only when required by the user.

.7 Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

.8 Terminals to be provided for a remote contact that opens to signal the ATS to transfer to emergency and for remote contact that open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.

.9 Controller to be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.

.10 Engine Exerciser – controller to provide an internal engine exerciser. Engine exerciser to allow the user to program up to seven different exercise routines. For each routine, the user will be able to:

- .1 Enable or disable the routine.
- .2 Enable or disable transfer of the load during routine.
- .3 Set the start time:
  - .1 Time of day
  - .2 Day of week
  - .3 Week of month (1st, 2nd, 3rd, 4th, alternate or every)
- .4 Set the duration of the run.

.11 At the end of the specified duration, the switch will transfer the load back to normal and run the generator for the specified cool down period. A ten year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

.12 System Status: Controller LCD display will include a “System Status” screen that will be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen will display a clear description of the active operating sequence and switch position. For example:

Normal Failed
Load on Normal
TD Normal to Emerg
2 min 15 s.

.13 Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the Operator’s Manual, are not permissible.

.14 Self-Diagnostics – Operator shall contain a diagnostic screen for the purpose of detecting system errors. This screen to provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.

.15 Communications Interface – Controller to be capable of interfacing, through a serial communication module to suit Modbus controls protocol.

.16 Data Logging – Controller to have the ability to log data and maintain the last 99 events, even in the event of total power loss. The following events will be time and date stamped and maintained in a non-volatile memory.

.1 Event Logging:

.1 Data and time and reason transfer normal to emergency.

.2 Data and time and reason for transfer emergency to normal.

.3 Data and time and reason for engine start.

.4 Data and time engine stopped.

.5 Data and time emergency source available.

.6 Data and time emergency source not available.

.2 Statistical Data:

.1 Total number of transfers.

.2 Total number of transfers due to source failure.

.3 Total number of days controller is energized.

.4 Total number of hours both normal and emergency sources are available.

2.4 ACCESSORIES

.1 Pilot lights to indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.

.2 Instruments:

.1 Data Monitor (Power Manager):

.1 Provide data monitors shown to monitor all functions specified below.

.2 The Data Monitors shall be listed to UL 3111-1, CSA, CE Mark, and industrially rated for an operating temperature range of -20°C to 60°C.

.3 The Data Monitor shall be accurate to 1% measured, 2% computed values and display resolution to .1%. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions (harmonics).

.4 The Data Monitor shall be capable of operating without modification at nominal frequencies of 45 to 66 Hz and over a control power input range of 20 – 32 VDC.

.5 Each Data Monitor shall be capable of interfacing with an optional communications module to permit information to be sent to central location for display, analysis, and logging.

.6 The Data Monitor shall accept inputs from industry standard instrument trans-formers (120 VAC secondary PTs and 5A secondary CTS.) Direct phase voltage connections, 600 VAC and under, shall be possible without the use of PTs.

.7 The Data Monitor shall be applied in three & four wire circuits. A fourth CT input shall be available to measure neutral or ground current.

.8 All setup parameters required by the Data Monitors shall be stored in non-volatile memory and retained in the event of a control power interruption.

.9 . Data Monitor Input/output Options:

.1 Data Monitors shall be equipped with the following I/O:

.2 Provide (8) solid state status inputs.

.3 Provide four (4) relay output contacts.

.10 The Data Monitor shall flush mount to an enclosure.

.1 The Data Monitors shall be equipped with an optional continuous duty, long-life, 4 line x 20 character LCD backlit display to provide local access to the following metered quantities:

.1 Current, per phase RMS and neutral (if applicable).
.2 Current Unbalance %
.3 Voltage, phase-to-phase and phase-to-neutral
.4 Voltage Unbalance %
.5 Real power, per phase and 3-phase total
.6 Apparent power, per phase and 3-phase total
.7 Reactive power, per phase and 3-phase total
.8 Power factor, 3-phase total & per phase
.9 Frequency
.10 Accumulated Energy, (MWH, MVAH, and MVARH)

.2 Displaying each of the Data Monitor quantities shall be accomplished through the use of menu scroll buttons.

.3 For ease in operator viewing, the display shall remain on continuously, with no detrimental effect on the life of the Data Monitor.

.4 Set-up for system requirements shall be allowed from the front of the Data Monitor. Set-up provisions shall include:

.1 CT rating
.2 PT rating
.3 System type 3 and 4 wire
.4 Communication parameters

.5 All reset and setup functions shall have a means for protection against unauthorized/accidental changes.

2.5 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Control panel:

.1 For selector switch and manual switch: nameplates.

.2 For meters, indicating lights, minor controls: equipment nameplate.

.3 Nameplates to include: equipment name plate with multiple power sources.

2.6 APPROVED MANUFACTURERS

.1 ASCO.

2.7 SOURCE QUALITY CONTROL

.1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Consultant.

.2 Notify Consultant in advance of date of factory test.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Locate, install and connect transfer equipment.

.2 Check relays, solid state monitors and adjust as required.

.3 Install and connect control cables for interface with generator control panel.

.4 Provide and connect power feeders for normal, emergency and load as indicated on drawings.

.5 Provide control cables for power loss (ATS call to start), Generator trouble, generator loss of power from each Transfer switch to the respective generator control panel.

3.2 FIELD QUALITY CONTROL

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

.2 Energize transfer equipment from normal power supply.

.3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

.4 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.

.5 Repeat, at one hour intervals, complete test with selector switch in each position, for each test.

3.3 TESTS

.1 Operate equipment both mechanically and electrically to ensure proper performance.

.2 Check selector switch in modes of operation; Test, Auto, Manual, Engine Start and Record Results.

.3 Check voltage sensing and time delay relay settings.

.4 Check:

.1 Automatic starting and transfer of load on failure of normal power.

.2 Retransfer of load when normal power supply resumed.

.3 Automatic shutdown.

.4 In-phase monitor operation.

.5 Additional testing shall be carried out as NETA standards by the Commissioning Agent.

3.4 TESTS AND CERTIFICATION

.1 The complete ATS will be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

.2 Upon request, the manufacturer will provide a notarized letter certifying compliance with all of the requirements of this specification, including compliance with the above-referenced codes and standards and withstand and closing ratings.

.3 The certification will identify, by serial number(s) the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, will be included in the certification.

.4 The ATB manufacturer will be certified to ISO 9001 International Quality Standard and the manufacturer will have third party certification verifying quality assurance in design/development, production, installation, and servicing in accordance with ISO 9001.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Equipment and installation for secondary lighting arresters.

1.2 REFERENCES

.1 Institute of Electrical and Electronics Engineers (IEEE):

.1 IEEE C62.1, Gapped Silicon-carbide Surge Arresters for AC Power Circuits;

.2 IEEE C62.11, Metal-oxide Surge Arresters for AC Power Circuits;

.3 IEEE C62.41, Surge Voltages in Low Voltage AC Power Circuits;

.4 IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.

.2 Underwriters Laboratories (UL):

.1 UL 1449-2006 – 3rd Edition, Transient Voltage Surge Suppressors;

.2 UL 1283-2005, Electromagnetic Interference Filters.

.3 International Electrotechnical Commission (IEC):

.1 IEC 61643-1, 2005, Low Voltage Surge Protective Devices.

.4 Canadian Standards Association (CSA):

.1 CSA 22.2, all applicable parts.

.5 International Organization for Standardization (ISO):

.1 The product must be manufactured by the vendor at its own facility, which is certified in conformance with ISO 9001 standards.

1.3 SUBMITTALS

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

.2 Product Data: Provide catalog sheets showing voltage, physical size, IEEE measured limiting voltage for each waveform listed, UL1449 latest revision, latest edition, voltage protection ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.

.3 Submit product data for all components and accessories.

.4 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.

.5 List and detail all protection systems such as fuses, disconnecting means and protective features.

.6 Provide verification that the SPD device complies with the required UL1449 latest edition, latest revision, CSA or ETL approvals.

.7 Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category C3 & C1 (combination wave) and A1 (ringwave) tested in accordance with ANSI/IEEE C62.45.

.8 Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds 40 dB at 100 kHz.

.9 Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8x20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.4 QUALITY ASSURANCE AND WARRANTY

.1 The panel mounted SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of thirty (30) years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Additionally, during the applicable warranty period, any SPD which fails due to any electrical anomaly, including lightning, shall be repaired or replaced by the manufacturer without charge. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

.2 Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this particular section. That is, the warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.

PART 2 - PRODUCTS

.1 Performance:

.1 General:

.1 The SPD shall be listed by ETL, UL, or other nationally recognized test laboratory to UL's 1283 and UL's 1449 standards (3rd edition, latest revision), and not merely the components or modules. All SPD's shall be Type 1 for use in Type 1 and Type 2 locations.

.2 The SPD shall protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.

.3 Obtain all surge suppression devices through one source from a single manufacturer.

.4 The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 220 and 240V systems, and 115% for 347 and 600V systems.

.5 All SPD's shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.

.6 No unit will be accepted as an “approved equal” unless it meets the warranty, strength, safety features, IEEE let-through levels, modes of discrete suppression circuitry, fusing, independent NEMA LS-1 per mode surge testing, and all other requirements of this specification.

.7 If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a 200kA symmetrical fault current with 600 VAC applied.

.8 Each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing at an independent, nationally recognized test laboratory. To be considered for approval, the manufacturer must submit a test report on a unit which was tested with internal over current fusing in place. The test shall include a UL1449 Second Edition surge defined as a 1.2 X 50 µsec 6000V open circuit voltage waveform and an 8 X 20 µsec 500A short circuit current waveform to benchmark the unit’s suppression voltage, followed by a single pulse surge of maximum rated surge current magnitude with an approximated 8 X 20 µsec waveform. To complete the test, another UL1449 surge shall be applied to verify the unit’s survival. Compliance is achieved if the suppression voltage found from the two UL1449 surges does not vary by more than +10%. Test data on an individual module is not acceptable.

.2 Main Switchboard 600V:

.1 SPD for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD’s shall be certified to UL 1283 and UL1449 Third Ed. Type 1 for use in Type 1 and Type 2 locations.

.2 Main Switchboard (600 V) BP1, shall be protected by a panel mounted SPD, model TK-ST300-3Y600-L for 347/600 wye (4W+G) volt panels or switchboards.

.3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B3/C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage
B3/C1 Impulse (6kV, 3kA)

Voltage	L-N	L-G	L-L	N-G
347/600	1273V	1281V	2161V	1295V

C3 Impulse (20kV, 10kA)

Voltage	L-N	L-G	L-L	N-G
347/600	1573V	1707V	2473V	1800V

UL Voltage Protection Ratings

Voltage	L-N	L-G	L-L	N-G
347/600	1500V	1500V	2500V	1500V

.4 The unit shall have a peak surge current of no less than 300kA/phase, 150kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.5 Internal Fusing - Overcurrent Protection:

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.

.2 For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.

.3 Fusing shall be present in every mode, including Neutral-to-Ground.

.4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

.6 The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

.7 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 4 steel enclosure.

.8 Provide 100A 3P breaker in Main Switchboard BP1.

.3 DP2E, DP2X, Emergency Panel 120/208V, Panel BP2.

.1 SPD for this location shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL 1283 and UL1449 Third Ed. Type 1 for use in Type 1 and Type 2 locations.

.2 Emergency Panel shall be protected by a panel mounted SPD, model TK-ST120-3Y208-L for 120/208 wye (4W+G) volt panels or switchboards.

.3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B3/C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage
B3/C1 Impulse (6kV, 3kA)

Voltage	L-N	L-G	L-L	N-G
120/208	651V	640V	1041V	646V

C3 Impulse (20kV, 10kA)

Voltage	L-N	L-G	L-L	N-G
120/208	960V	1010V	1310V	860V

UL Voltage Protection Ratings

Voltage	L-N	L-G	L-L	N-G
120/208	700V	700V	1200V	700V

.4 The unit shall have a peak surge current of no less than 120kA/phase, 60kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.5 Internal Fusing - Overcurrent Protection:

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.

.2 For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.

.3 Fusing shall be present in every mode, including Neutral-to-Ground.

.4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

.6 The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

.7 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 4 steel enclosure.

.8 Provide 60A 3P breaker in DP2C, DP2X, Panel BP2.

.4 DPIE Emergency Generator Panel:

.1 SPDs for these locations shall be as indicated on project drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL 1283 and UL1449 Third Ed. Type 1 for use in Type 1 and Type 2 locations.

.2 Emergency Generator Panel: panels shall be protected by a panel mounted SPD, model TK-ST120-600NN-L for 600 delta (3W+G) volt panels.

.3 The manufacturer shall provide written specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B3/C1 and C3 bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage
B3/C1 Impulse (6kV, 3kA)

Voltage	L-G	L-L
600 delta	2202V	2217V

C3 Impulse (20kV, 10kA)

Voltage	L-G	L-L
600 delta	2420V	24107V

UL Voltage Protection Ratings

Voltage	L-G	L-L
600 delta	2500V	2500V

.4 The unit shall have a peak surge current of no less than 120kA/phase, 60kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

.5 Internal Fusing - Overcurrent Protection:

.1 Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more than one MOV per mode.

.2 For arc quenching capability, minimization of smoke and contaminates in the event of a failure, and to ensure the safest possible design, all surge components, current carrying paths and fusing shall be packed in fuse grade silica sand.

.3 Fusing shall be present in every mode, including Neutral-to-Ground.

.4 The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

.6 The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

.7 The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability, and shall have at minimum a Nema 4 steel enclosure.

.8 Provide 60A 3P breaker for each SPD.

2.2 ENCLOSURE

.1 The SPD is to be separately enclosed and not integral to any switchboard or branch panel. The TVSS enclosure must be metallic NEMA 1 or 4 rated, standard finish.

.2 All components must be installed within the enclosure and shop assembled by the manufacturer before shipping to site.

.3 Enclosure must be:

.1 Tamper resistant to limit access to internal components; or

.2 If easily opened, must come complete with a CSA rated, local disconnect to ensure power to the TVSS is removed from its internal components prior to opening the enclosure door.

.4 Must be identified with applicable warnings and CSA ratings/approvals.

2.3 GROUNDING

.1 Provide a separate insulated bond wire, sized as per manufacturer’s recommendations and to meet minimum requirements of the Ontario Electrical Safe Authority.

.2 Bond wire is to be run directly and as short as practical to the ground bus.

2.4 OPERATION DESIGN REQUIREMENTS

.1 General:

.1 The SPD shall not generate any appreciable magnetic fields and shall be suitable for direct use within computer rooms.

.2 The SPD shall not generate any appreciable noise.

.3 Each MOV module of the TVSS shall not contain any combustible materials.

.4 Failure mode of the SPD shall not create any safety hazard, including smoke, flame, or arch flash.

.5 Operation of the SPD shall not cause an interruption of normal power to the protected loads.

.6 EMI and RFI noise rejected by the TVSS operation is to be in compliance with NEMA LS1.

.7 Electrically isolated dry contacts shall be available which can be connected to a remote alarming system.

.8 Bond wire is to be run directly and as short as practical to the ground bus.

.2 Testing Documentation:

.1 Single Pulse Current Capacity:

.1 SPD systems are to be single pulse surge current tested in all modes at rated surge currents by an industry recognized independent test laboratory.

.2 Test methods are to be shown to be conducted as per NEMA LS1 and UL 1449 surge testing procedures and shall not demonstrate more than 10% variance in the protected side rated voltage.

.2 Minimum Repetitive Surge Current Capacity:

.1 SPD systems are to be repetitive surge current capacity tested in all modes by an industry recognized independent test laboratory.

.2 Test methods are to be shown to be conducted as per IEEE C62.41 and IEEE C62.45 testing procedures and shall not demonstrate performance degradation or more than 10% variance in the protected side rated voltage.

2.5 MANUFACTURERS

.1 Manufacturers for SPDs shall be as follows:

.1 Total Protection Solutions

.2 Current Technology TransGuard TG Series

.3 Liebert SI Series.

.2 Acceptable Manufacturers:

.1 NOTE: Listing of a manufacturer's name does not indicate acceptance of the manufacturer's product line. The specifications must be met for the product to be accepted.)

PART 3 - EXECUTION

.1 Installation:

.1 Install each SPD as close as possible to the distribution equipment it is meant to protect.

.2 Coordinate and provide breakers in panel board for SPD devices.

.3 SPDs installed in Panel boards are NOT acceptable.

.4 Cable and ground wire lengths are to be direct as possible.

.1 Install the SPD's with the conductors as short and straight as practically possible.

.2 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. The electrical contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.

.3 The installing contractor shall comply with all applicable codes.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (ANSI/IEEE):
  .1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

.2 ASTM International Inc.:
  .1 ASTM F 1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.3 Canadian Standards Association (CSA International).

.4 ICES-005-07, Radio Frequency Lighting Devices.

.5 Underwriters Laboratories of Canada (ULC).

1.2 ACTION AND INFORMAITONAL SUBMITTALS

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

.2 Product Data:
  .1 Provide manufacturer's printed product literature, specifications and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
  .2 Provide complete photometric data prepared by independent testing laboratory for luminaries where specified, for approval by Consultant.

.3 Quality Assurance Submittals: provide the following in accordance with Section 01 45- 00 – Quality Control.
  .1 Manufacturer's Instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.3 QUALITY ASSURANCE

.1 Provide mock-ups in accordance with Section 01 45 00 – Quality Control.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements.

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

.3 Divert unused metal materials from landfill to metal recycling facility.

.4 Disposal and recycling of fluorescent lamps as per local regulations.

.5 Disposal of old PCB filled ballasts.

PART 2 - PRODUCTS

2.1 LAMPS

.1 LED as noted on drawings.

2.2 FINISHES

.1 Light fixture finishes and construction to meet ULC listings and CSA certifications related to intended installation.

2.3 OPTICAL CONTROL DEVICES

.1 As indicated in luminaire schedule.

2.4 LUMINAIRES

.1 As indicated in luminaire schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Locate and install luminaires as indicated.

.2 Provide adequate support to suit ceiling system.

3.2 WIRING

.1 Connect luminaires to lighting circuits:
  .1 Install flexible or rigid conduit for luminaires as indicated.

3.3 LUMINAIRE SUPPORTS

.1 For suspended ceiling installations, support luminaires independently of ceiling.

3.4 LUMINAIR ALIGNMENT

.1 Alight luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 CSA International:
  .1 CSA C22.2 No.141-10, Emergency Lighting Equipment.

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 emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 – Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

1.4 WARRANTY

.1 For batteries in this section - 26 52 00 – Emergency Lighting, 12 months warranty period is extended to 120 months.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Emergency lighting equipment: to CSA C22.2 No.141.

.2 Supply voltage: 120 V, ac.

.3 Output voltage: 24 V, dc.

.4 Operating time: 120 minutes.

.5 Battery: sealed, maintenance free, with sufficient capacity to provide 91% voltage after 30 minutes operation with connected load plus 50 W.

.6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.

.7 Solid state transfer circuit.

.8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

.10 Lamp heads: integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: LED and lumen minimum output as indicated on drawings.

.11 Cabinet: suitable for direct or shelf mounting to wall and complete with knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.12 Auxiliary equipment:
- .1 Ammeter.
- .2 Voltmeter.
- .3 Test switch.
- .4 Time delay relay.
- .5 Battery disconnect device.
- .6 AC input and DC output terminal blocks inside cabinet.
- .7 Mounting bracket
- .8 Cord and plug connection for AC.
- .9 RFI suppressors.

2.2 WIRING OF REMOTE HEADS

.1 Conduit: in accordance with Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

.2 Conductors: in accordance with Section 26 05 21 – Wires and Cables (0-1000 V), sized as indicated in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for emergency lighting installation in accordance with manufacturer's written instructions.
- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Install unit equipment in main Electrical Room in front of transfer switches.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by emergency lighting installation.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA C22.2 No.141-10, Unit Equipment for Emergency Lighting.
- .2 CSA C860-01-Latest Edition, Performance of Internally-Lighted Exit Signs.

.2 National Fire Protection Association (NFPA):
- .1 NFPA 101-Latest Edition, Life Safety Code.

1.2 SUBMITTALS

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

.2 All pictogram exit lighting sign shop drawings are to be submitted for review and comment prior to issuing to Engineer for review. All comments and transmittal documents to be attached to shop drawings being issued to Engineer.

.3 Product Data:
- .1 Submit manufacturer's printed product literature, specifications and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

.4 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29 – Health and Safety Requirements and manufacturer’s instructions.

.5 Quality Assurance Submittals: Submit following in accordance with Section 01 45 00 – Quality Control.
- .1 Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

PART 2 - PRODUCTS

2.1 STANDARD UNITS

.1 Exit Lights: to CSA C22.2 No.141 and CSA C860.

.2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish.

.3 Face and back plates: cast aluminum alloy.

.4 Lamps: LED-12W, 120V, over 500,000 hours.

.5 Letters: as detailed on Drawings.

.6 Faceplate to remain captive for relamping.

2.2 DESIGN TYPES

.1 Single-Face Pictogram X1: (Running man in doorway) for mounting above or beside egress doors.

.2 Single-Face Pictogram X2: (Running man in doorway with progress left and/or right 90 degree directional arrow) for egress routing through corridors and spaces.

.3 Double-Face Pictogram X3: (Running man in doorway with progress left and/or right 90 degree directional arrow's) for egress routing through corridors and spaces.

.4 Single-Face Pictogram X4: (Running man in doorway with progress down to the left and/or down to the right 45 degree directional arrow) for egress routing through corridors and spaces at open stairs and ramps.

.5 Double-Face Pictogram X5: (Running man in doorway with progress down to the left and/or down to the right 45 degree directional arrow's) for egress routing through corridors and spaces at open stairs and ramps.

.6 Single-Face Pictogram X6: (Running man in doorway with progress up to the left and/or up to the right 45 degree directional arrow) for egress routing through corridors and spaces at open stairs and ramps.

.7 Double-Face Pictogram X7: (Running man in doorway with progress up to the left and/or up to the right 45 degree directional arrow's) for egress routing through corridors and spaces at open stairs and ramps.

2.3 DESIGN

.1 Universal mounting.

.2 Single Double face with die-cast face plate to remain captive for re-lamping.

.3 Arrow: as indicated on drawings.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.

.2 Connect fixtures to exit light circuits.

.3 Connect emergency lamp sockets to emergency circuits.

.4 Ensure that exit light circuit breaker is locked in on position.

END OF SECTION

Appendix 'A'

Designated Substances Survey and Perchlorate Detection in Fume Hoods, OVC – Former VMI Building

Prepared by LEX Scientific Inc., June 2018 (LEX Project No. 01180066)

LEX Project No. 01180066

SOLUTIONS
FOR A WORKING WORLD

University of Guelph – Physical Resource Dept.

Designated Substance Survey and Perchlorate Detection in Fume Hoods

OVC - Former VMI Building

June 2018

Prepared by:
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June 26, 2018
LEX Project No. 01180066

Mr. Peter Ibrajev
University of Guelph – Physical Resource Dept.
J.C. Hersey Building, 117 College Avenue East, Guelph ON, N1G 2W1

Re: Designated Substance Survey and Perchlorate Detection in Fume Hoods
OVC - Former VMI Building

Dear Mr. Ibrajev:

LEX Scientific Inc. (LEX) was retained by University of Guelph – Physical Resource Dept.to conduct a Designated Substances Survey (DSS) for the Ontario Veterinary College OVC - Former VMI Building located at 50 College Ave, West, Guelph ON. The survey was conducted in support of planned renovations and included the inspection of asbestos-containing materials (ACMs), the investigation of potential lead and mercury-containing materials within the building, and the inspection for other designated substances. In addition to the DSS, LEX tested the interior of fume hoods located in the facility for potential perchlorate residues.

This designated substance survey was conducted to ensure compliance with Section 30(1) of the Occupational Health and Safety Act which states:

"*Before beginning a project, the owner shall determine whether any designated substances are present at the project site and shall prepare a list of all designated substances that are present at the site.*"

On behalf of LEX, we would like to thank you for the opportunity to serve you. If you have any questions regarding this report or any health and safety issue, please call us at (519).824.7082.

Yours truly,

LEX Scientific Inc.

Daniel Humphrey, B.B.R.M.
Environmental Technologist

Eric Hoffbauer, P.Eng.
Project Manager – Consulting Services

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Executive Summary

University of Guelph – Physical Resource Dept. retained LEX to conduct a DSS of the OVC - Former VMI Building. The survey was requested to quantify the designated substances on the premises before renovations are scheduled to begin. In addition, fume hoods in the facility were tested for perchlorate residues.

Summary of Designated Substances and Hazardous Materials

Designated Substance Observed	Material	Location	Approximate Quantity
Asbestos	Black mastic	Black mastic was found throughout the building **except** where there is terrazzo flooring, concrete flooring or beneath LEX samples 07, 27, 29. **Note LEX samples 07, 27, 29 may have areas within the building where black mastic is present that was not observed by LEX.*	18,000 sq. ft.
Asbestos	Vinyl Flooring Tile (VFT) – Olive with white streaks 9x9	138A, 138B, 215, 215A, 215B, 215C, 215D, 216, 112, C201	256 sq. ft.
Asbestos	VFT – Brown with white streaks 9x9	132A, 221, Penthouse Mechanical Room 222 (Bottom of stairs), 209, 209A, 210, 210A, 210B, 210C,	612 sq. ft.
Asbestos	VFT – Grey with white streaks 9x9	128, 117A, 117B, 125B, 125A, 125, 126B, 126D, 214A, 214B, 215, 215A, 215B, 111, 203, 203A, 206A, 206B, 206C	2223 sq. ft.
Asbestos	VFT – Green/Blue	126	270 sq. ft.
Asbestos	VFT – White with green streaks 9x9	132B, 126D	160 sq. ft.
Asbestos	VFT – Teal with white 9x9	119	96 sq. ft.
Asbestos	VFT – Grey with black 9x9	123, 124	432 sq. ft.

Designated Substance Observed	Material	Location	Approximate Quantity
Asbestos	VFT – Black with white streaks	204B	40 sq. ft.
Asbestos	VFT – Brown with multicolour streaks 9x9	203, 208, 210, 210A, 210B, 210C	912 sq. ft.
Asbestos	VFT – Blue with white streaks 9x9	215, 215A, 215B, 215C, 215D, 216, 223, 204B, 213, 213A, 213B, 213C	839 sq. ft.
Asbestos	VFT – White with brown streaks 9x9	215C, 215D, 216, 219A, 219B, 220, 102, 203B, 207, 207B	1489 sq. ft.
Asbestos	VFT – Red with white streaks 9x9	219, 219A, 219B, 219C, 128, 209, 209A, C201	700 sq. ft.
Asbestos	VFT – Army green with white streaks	213, 213A, 213B, 213C	170 sq. ft.
Presumed Asbestos	Sink undercoating - Gold	209, 209A	2 units
Asbestos	Parged pipe fittings	128, 130, 132, 133, 135, 138, 138A, 138B, 139, 139A, 140, 140A Washroom 130, Washroom 117, 117A, 117B, 119, Sewage Room 120A, 123, 125A, 125B, 126, 126A, 126E, 127, Washroom 116, 116, 109, 109A, 109B, 102, 128, 124, 113A, Corridor 102, Corridor 103, 203, 204B, 206B, 206C, 209, 209A, 223, Corridor 201, Penthouse Mechanical Room 222	411 fittings
Presumed Asbestos	Parged pipe wrapping	Penthouse Mechanical Room 222, Sewage Room 120A	6000 sq. ft.
Presumed Asbestos	Transite Board	138	70 sq. ft.
Asbestos	Parged pipe fittings – **Inaccessible** ceiling hatch	129, 132A, 132B, 132C, 117A, 117B, 121, 126D, Washroom 202, 201, Atrium 202,	Unknown

Designated Substance Observed	Material	Location	Approximate Quantity
		Corridor 100, all stairwells	
Mercury	Fluorescent light bulbs	Throughout Entire Building	1137 units
Polychlorinated Biphenyls (PCB)	Light ballasts	Throughout Entire Building	578 units
Lead	Copper and cast-iron pipe solder	Found in ceiling spaces, beneath laboratory work benches, and in corridors	Throughout Entire Building
Lead	Lead containing paint	Throughout Entire Building	N/A

No perchlorate residues were detected by LEX on the interior surfaces of the fume hoods.

Summary of Recommendations

- Any ACM that may be disturbed during the renovation should be removed by a qualified abatement contractor prior to initiation of renovations.
- Any lead containing materials disturbed during the renovations should be completed using the Ontario Ministry of Labour guideline *Lead on Construction Projects.*
- It is recommended that a copy of this DSS should be kept on-site during any renovation or demolition activities. It should also be provided to all contractors who may disturb any of the designated substances mentioned in this report.
- Coring, sawing or breaking of materials such as concrete, brick and mortar should be considered silica-containing and should be done with appropriate dust suppression methods and proper respiratory protection and following Guideline - Silica on Construction Projects (published September 2004 and revised April 2011).
- Any fluorescent light tubes that will be removed should be collected and disposed of by being sent to an appropriate recycling facility. Fluorescent tubes should be packed in a rigid container to mitigate any circumstances that may result in breaking of light tubes and release of mercury vapour. Broken light tubes should also be packed in the same container for disposal.
- Any light ballasts that will be removed should be collected from the site, checked for PCB content and disposed of by sending to an appropriate facility. LEX has a directory of ballast types and manufacturers and has staff that can assist in sorting any light ballasts removed during renovations as PCB and non-PCB containing for appropriate disposal.

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1 Introduction

The University of Guelph – Physical Resource Dept. retained LEX to conduct a DSS at the OVC - Former VMI Building. In addition, LEX preformed perchlorate detection testing in fume hoods that were located within the scope of work to determine if there were any perchlorate residues present. This building is a multi-use, multi-storey building and was used by the Ontario Veterinary College (OVC) as their Veterinary Microbiology and Immunology facility.

The DSS assessment was performed by Dan Humphrey, B.B.R.M (Env Mgmt.)., Environmental Technologist and Jarrett Deneau, B.Sc. Environmental Technologist between May 14-18, 2018. The survey included the inspection of asbestos-containing materials (ACMs), the investigation of potential lead and mercury-containing materials within the building and the inspection for other designated substances. It is understood that the survey was requested to quantify the designated substances on the premises prior to initiation of planned renovations.

The survey included the inspection of asbestos-containing materials (ACMs), the investigation of potential lead and mercury-containing materials within the building and the inspection for other designated substances. The scope of work encompassed all floors, walls, ceilings, and interior finishes of the building. LEX conducted semi-invasive sampling and visual identification during the survey.

Within the limitations presented, the survey has been completed and the results are contained in this report. All work was performed according to the Regulation respecting Asbestos on Construction Projects and in Buildings and Repair Operations (Ontario Regulation 278/05); Designated Substances in the Workplace (Ontario Regulation 490/09) - made under the Occupational Health and Safety Act.

2 Definition of Designated Substances and Applicable Guidelines

2.1 Asbestos Containing Material (ACM)

Ontario Regulation 278/05 Section 1 and 3 (4) defines an ACM as being a material that contains 0.5 percent or more asbestos by dry weight. ACMs have been proven to cause diseases like mesothelioma, asbestosis and lung cancer. Health Canada states that asbestos fibres pose significantly less health risks if they are in tightly bound or in enclosed form. Any form of alteration or renovation to the ACM needs to be performed by certified professional.

Ontario Regulation 278/05 requires that final clearance air monitoring be conducted following all Type III Asbestos Removal Operations to ensure the work enclosure is clean and is suitable for worker/tenant re-occupancy. The Type III work enclosure "passes the clearance test only if every air sample collected has a concentration of fibres that does not exceed 0.01 fibres per cubic centimetre of air[1]".

2.2 Lead

Lead is used in a wide variety of products including the manufacture of storage batteries, plastic stabilizers and paints, ammunition, cable coverings in the power and communication industries, and lead sheet for roofing.

Acute exposure to lead by inhalation or ingestion may cause headache, fatigue, nausea, abdominal cramps, and joint pain and bloody diarrhoea. Chronic (long term) exposure to lead by inhalation or ingestion can cause reduced haemoglobin production, reduced life span, disturbances to vision and kidney damage. Lead exposure may also cause harmful effects on pregnancy and reproduction, is mutagenic and possibly carcinogenic to humans.

O. Reg. 490/09 limits occupational exposure to elemental lead to 0.05 mg/m^3 TWA (8 hour) for workers, but excludes construction projects. However, the Ministry of Labour Guideline - *Lead On Construction Projects* (published September 2004 and revised April 2011) requires an equivalent level of protection to be implemented. Adopting the exposure limit value for workers on construction projects would be a prudent practice.

Lead was also historically used in solder for interior plumbing. However, lead has been banned for use in solder since approximately 1990. Lead piping was also used in plumbing for buildings constructed before 1975. Building age can be used to determine the presence of lead piping or lead containing solder in plumbing systems.

2.3 Mercury

Mercury and mercury compounds are known to cause central nervous system impairment as well as kidney damage. Mercury in the elemental form was historically used in various applications including in buildings as part of thermostat switches and light switches. Mercury is also used in fluorescent lighting tubes.

Ontario Regulation 490/09 – Designated Substances limits worker exposure to mercury and mercury compounds to 0.01 mg/m^3. O*ntario Regulation 347 - General Waste Management*, encourages the recycling of "common mercury wastes" including mercury-containing lamps and thermostats.

2.4 Silica

Silica, or silicon dioxide (SiO_2), is a mineral constituting about 60% of the earth's crust. The regulated forms of crystalline silica are quartz, cristobalite, tridymite, and tripoli.

Silica sand and gravel are commonly used in road construction, buildings (concrete), ceramic and refractory materials. Respiratory impairment and disease among workers exposed to mineral dusts have been historically documented. Silicosis (or silica-induced pneumoconiosis) is the result of deposition of crystalline silica particles in the lung tissue. Prolonged and continued exposure to silica dust may cause progressive silicosis resulting in respiratory failure.

O. Reg. 490/09 limits occupational exposure limit for crystalline silica, quartz/ tripoli at 0.1 mg/m^3 TWA (8-hour) and cristobalite at 0.05 mg/m^3 TWA (8 hour).

2.5 Other Designated Substances

The other designated substances are:

- Acrylonitrile;
- Arsenic;
- Benzene;
- Ethylene Oxide;
- Isocyanates; and
- Vinyl Chloride.

- Coke Oven Emissions;

2.6 Perchlorate Compounds

Perchlorate is a naturally occurring and man-made material commonly used as an oxidizer in solid propellants, munitions, fireworks, airbag initiators, matches and signal flares. It is also used in some electroplating operations and found in some disinfectants and herbicides (United States Environmental Protection Agency [EPA], 2014). The presence of perchlorates inside a fume hood may present an explosion hazard under certain conditions if the fume hood is exposed to a physical shock.

2.7 Semi-invasive Sampling

For the purpose of this report semi-invasive sampling included visual inspections of building materials, sampling of wall finishes and pulling up corners of carpet tiles to exam flooring underneath without leaving evidence of extensive of disturbances. Since LEX staff were able to access and inspect the wall spaces from areas above the ceiling, coring was not required to identify if loose fill insulation was present in wall cavities. LEX was able to see into wall cavities at three different locations across the two wings.

3 Survey Methodology

3.1 Building Surveyed

Table 1 summarizes the rooms and building(s) surveyed as part of this DSS.

Table 1 Inspection Location Summary

Building Address	Areas Surveyed	Areas Excluded from Survey
50 College Ave, West, Guelph ON – Wing B and C	First Floor Second Floor Penthouse (Mechanical Room) Basement rooms 120A (Mechanical Room) and 120B (Sewage Room) Corridors C100, C101, C102, C103, C201, C202, AT202 Stairwells ST101, ST102, ST103, ST201, ST202, ST203, ST205	Rooms 109D (Cooler), 109E (Freezer), 207A (Cold Room), 202 (Cold Room), 204A (Storage), EL200

3.2 Survey Methodology

A walk-through visual inspection and non-invasive sampling was performed to determine the condition of asbestos containing materials **(ACM)** and the presence of all other Designated Substances. In addition, areas of the building where flooring carpet tile were present LEX pulled up corners of carpet tiles to examine flooring materials below. The materials of interest included, but were not limited to:

1. Thermal System Insulation **(TSI)** including pipe insulation, pipe fittings, boiler insulation, and duct insulation.
2. Surfacing materials including spray-on fireproofing, troweled-on material and decorative coatings.
3. Miscellaneous materials including vibration cloth, transite board or pipes, asbestos cement composite, ceiling tiles, and floor tiles.
4. Deteriorating paint coatings on walls, ceilings, pipes etc.
5. Mercury-containing electrical switches, lights and thermostats.

Representative bulk samples were collected of suspect ACM present in the building. Two representative paint samples were taken from surfaces with deteriorating/peeling paint in the areas inspected and were analysed for lead content. Visual identification of mercury-containing materials such as electrical switches and thermostats was conducted during the survey.

Details of fume hood usage by staff and students is not known. Since historical perchloric acid usage can result in perchlorate residues present in the fume hoods which can present an explosive hazard, testing for perchlorates was conducted in response to anticipated renovation plans for the building. Perchlorate testing was conducted in the fume hoods located to the following rooms:

- 209 (1 fume hood identified)
- 206B (1 fume hood identified)
- 213A (1 fume hood identified)
- 123 (1 fume hood identified)

Three tests were completed per fume hood following stated methodology. Test locations included interior left paneling, interior right paneling, and interior top paneling of each fume hood. The perchlorate testing in the fume hoods was conducted using a testing method involving methyl blue dye solution. Distilled water was sprayed on the interior surfaces of the fume hood and allowed to wash down the sides. A cotton tipped swab was then moistened with the water from the side of the fume hood and placed on a sterile piece of filter paper. A small amount of methyl blue dye solution was then dropped onto the swab and filter paper. When perchlorate is present, the methyl blue reacts to form violet precipitates.

3.3 Survey Impediments

The following impediments were encountered during the survey:

- Inaccessible locks on rooms 109D (Cooler), 109E (Freezer), 207A (Cold Room), 202 (Cold Room), 204A (Storage).
- Limited view, or inaccessible ceiling hatches in some rooms throughout the survey. For room by room notes refer to Appendix E.
- Inaccessible elevator shaft (EL 200).

*Note: LEX was able to gain access to cold room 136B. It was reported to LEX by Mr. Peter Ibrajev that this cold room is representative of the other cold/freezer rooms within the building that were inaccessible during the investigation.

3.4 Laboratory Analysis

Each bulk sample submitted to the LEX Laboratory was analysed as per EPA method 600/R-93/116 and was performed in compliance with the Code for the Determination of Asbestos from Bulk Samples found in the Regulation regarding Asbestos on Construction Projects and in Buildings and Repair Operations - made under the Occupational Health and Safety Act, Ontario Regulation 278/05.

LEX is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) and by the National Institute of Standards and Technology. The National Voluntary Laboratory Accreditation Program is a United States based laboratory accreditation for analyzing bulk materials for asbestos content. Our NVLAP Lab Code number is 101949.

Paint chip samples were analyzed by Maxxam Analytics for lead content.

4 Results and Discussion

4.1 Survey Visual Observations

The following observations were made during the investigation:

- LEX observed cast iron and copper piping throughout the building.
- LEX observed fluorescent light bulbs throughout the building.
- LEX observed a water leak in room 125B. In addition, water damage was observed on ceiling tiles in 125A.
- LEX observed some parged pipe fitting/insulation remediation efforts in basement room 120, the Penthouse Mechanical Room, and corridor C102.
- Invasive coring of exterior walls was avoided by LEX since there were multiple locations where wall cinder blocking was damaged and visual inspections of the wall cavity could be made. No suspect ACM materials where observed by LEX in these areas.

4.2 Asbestos Containing Materials

4.2.1 Bulk Sampling Results

Table 2 below, summarizes the analytical laboratory results of homogeneous materials collected from OVC - Former VMI Building. Note that the locations listed below pertain only to the physical samples submitted for lab analysis.

Table 2 Summary of Homogenous Materials Collected

Sample ID	Sample Location	Description	Friability	% Fibrous Asbestos Content
01	C100, 140, 138A, ST101, ST103, 110, 101	Plaster (Scratch and Finish Layers)	No	Non-containing
02	C100	Ceiling Tile (CT) – Large/Small Pinholes	Yes	Non-containing
03	C100	CT – Glue Pucks 9x9	Yes	Non-containing
04	C100	CT – Rough	Yes	Non-containing
05	140, 139, 135	Window Caulking (White)	No	Non-containing
06	135, 140, 132	Baseboard Mastic #1 (BBM)	No	Non-containing
07	140, 132	VFT – Brown with Grey and Mastic - Orange	No	Non-containing
08	128	Parged Pipe Fitting	Yes	50% Chrysotile
09*	139, 135	Tar Duct Insulation	Yes	<0.5 Chrysotile -- Considered non-ACM
10	139A	Sink Undercoat – Blue	No	Non-containing
11	138, 125B, 125A	BBM #2	No	Non-containing
12	138, 127	VFT – White with Black	No	Non-containing
		Black mastic	No	1% Chrysotile
13	138A, 138B	VFT – Olive with White Streaks 9x9	No	0.5% Chrysotile
		Black mastic	No	1% Chrysotile
14	138	VFT – White with Grey	No	Non-containing
		Black mastic	No	1% Chrysotile
15	136, 133, 206, 204, 113	Drywall Joint Filling Compound (DWJFC)	No	Non-containing
16	132, 132B	Carpet Tile Mastic (Yellow)	No	Non-containing
17	132A	VFT – Brown with White Streaks 9x9	No	0.5% Chrysotile
		Black mastic	No	1% Chrysotile
18	128	VFT – Grey with White Streaks 9x9	No	0.5% Chrysotile

Sample ID	Sample Location	Description	Friability	% Fibrous Asbestos Content
		Black mastic	No	1% Chrysotile
19	126	VFT – Green/Blue	No	0.5% Chrysotile
		Black mastic	No	1% Chrysotile
20	126D	VFT – White with Green Streaks 9x9	No	2% Chrysotile
		Black mastic	No	1% Chrysotile
21	126E, 126, 126D	Leveling Compound - Grey	No	Non-containing
22	126	Flexible Pipe Insulation	No	Non-containing
23	119	VFT – Teal with White 9x9	No	1% Chrysotile
		Black mastic	No	1% Chrysotile
24	123	VFT – Beige with Brown	No	Non-containing
		Black mastic	No	1% Chrysotile
25	123, 124	VFT – Grey with Black 9x9	No	1% Chrysotile
		Black mastic	No	1% Chrysotile
26	123, 124	VFT – Oatmeal Pattern	No	Non-containing
		Black mastic	No	1% Chrysotile
27	203	VFT – Purple with White Speckles	No	Non-containing
28	125A	Sink Undercoat - White	No	Non-containing
29	203	VFT – Cream	No	Non-containing
30	203	VFT – Brown with Multi-Colour Streaks 9x9	No	0.5% Chrysotile
		Black mastic	No	1% Chrysotile
31	203B	VFT – White with Brown Streaks 9x9	No	1% Chrysotile
		Black mastic	No	1% Chrysotile
32	204B	VFT – Blue with White Streaks 9x9	No	0.5% Chrysotile
		Black mastic	No	1% Chrysotile
33	204B	VFT – Black with White Streaks	No	6% Chrysotile
		Black mastic	No	1% Chrysotile
34	204B	VFT – Grey with Black Streaks	No	Non-containing
		Black mastic	No	1% Chrysotile

Sample ID	Sample Location	Description	Friability	% Fibrous Asbestos Content
35	206	CT – Bumps with Pinholes 2x4	Yes	Non-containing
36	209	VFT – Red with White Streaks 9x9	No	1% Chrysotile
		Black mastic	No	1% Chrysotile
37	209	VFT – Red/Orange	No	Non-containing
		Black mastic	No	1% Chrysotile
38	213	VFT – Dark Multi-Coloured Red	No	Non-containing
		Black mastic	No	1% Chrysotile
39	101	VFT – Army Green with White	No	1% Chrysotile
		Black mastic	No	1% Chrysotile
40	105	CT – Texture with Pinholes and Fissures 2x2	Yes	Non-containing
41	105	Black Pipe Insulation	No	Non-containing
42	112	VFT – Multi-Grey	No	Non-containing
		Black mastic	No	1% Chrysotile
43	113	Vinyl Flooring Sheet (VFS) – Dark Grey	No	Non-containing
44	111	VFT – Tan and Brown	No	Non-containing
		Black mastic	No	1% Chrysotile

Notes:
1. Shaded samples are asbestos containing.
2. Containing black mastic was sampled under LEX sample ID 12. Black mastic was observed by LEX under all VFT's within scope of work **except** for VFT LEX samples 07, 27, 29. However, the extent to which black mastic was observed was limited to only the areas where LEX sampled VFT. (Observable extent of black mastic in each room was restricted due to our inability to look under every VFT in each room.)
3. * - samples found with <0.5% asbestos content are **not** considered to be asbestos containing per O.Reg. 278/05.

Appendix A contains the summary photolog of sampled and noteworthy materials. Refer to **Appendix B** for the Laboratory Certificates of Analysis for bulk asbestos materials sampled.

4.2.2 Asbestos Containing Materials Quantification

Appendix D contains a listing and quantification of all ACM observed in the OVC - Former VMI Building.

4.3 Lead Containing Materials

4.3.1 Lead Based Paint and Mortar

Table 3 below, summarizes the results of the paint coat sampling. The lead concentrations are expressed in milligram lead per kilogram of paint (mg/kg) as well as in percent lead. Paint samples are to be considered lead-based, if they contain greater than 0.5% lead on a mass basis. Paint samples are considered lead-containing if they consist of less than 0.5% lead on a mass basis.

Table 3 Summary of Paint Sample Laboratory Analysis

Sample ID	Sample Location	Description and Colour	Lead Content (mg/kg)	Lead Content (%)
L-01	138	Grey Paint	2600	0.260
L-02	223	Beige Paint	290	0.029

Beige paint was present in the majority of the window frame areas and some walls throughout the building. Grey paint was located throughout the building on the interior of exterior walls. Both paint samples collected were found to be lead-containing rather than lead based. The samples collected would be considered representative of the paint encountered within the building. Refer to **Appendix C** for the Laboratory Certificates of Analysis of lead in paint chip samples.

4.3.2 Other Lead-Containing Materials

Lead-Containing Solder - All solder if present, are to be presumed lead-containing. All joints on cast iron sewer pipes are also to be presumed lead-containing. Disturbance of any lead-containing materials should only be done according to the *Guideline Lead On Construction Projects* (April 2011).

4.4 Mercury

Mercury-containing thermostats were not observed in the building. All fluorescent light tubes present should be considered to contain mercury.

4.5 Silica

No samples were collected for silica during the survey. Coring, sawing or breaking of materials such as concrete, brick and mortar should be considered silica-containing and should be done with appropriate dust suppression methods and proper respiratory protection and following *Guideline - Silica on Construction Projects* (published September 2004 and revised April 2011).

4.6 Other Designated Substances

The following designated substances were not observed at the building:

- Acrylonitrile;
- Arsenic;
- Benzene;
- Coke Oven Emissions;
- Ethylene Oxide;
- Isocyanates; and
- Vinyl Chloride.

4.7 Perchlorate

Table 4 below summarizes the results of the testing for the presence of perchlorates in the fume hoods.

Table 4 Perchlorate Presence in Fume Hoods

Room Number	Violet Precipitate Formed
123	No
206B	No
209	No
213A	No

No violet colouring or precipitates were observed on any of the filter papers or swabs. A total of three test were completed at each fume hood. Refer to **Appendix A** for representative perchlorate test results.

Based on these results, perchlorates were not detected on any of the interior surfaces of the fume hoods tested.

It should be noted, that only the accessible interior surfaces of the fume hood were tested. No tests were conducted inside the fume hood ducting. Exhaust ducting for the fume hood may still pose an explosion hazard upon physical shock, due to presence of perchlorates. Even though perchlorates were not detected, precautionary work procedures should be used.

5 Conclusions

1. LEX sample 08 (Parged Pipe Fitting), found throughout the building, was determined to be an asbestos containing material. Some parged pipe fitting remediation efforts were observed by LEX throughout the building.
2. Parged pipe wrapping found in the Sewage Room 120A and the Penthouse Mechanical room 222 were presumed to be asbestos containing. Some parged pipe wrapping remediation efforts were observed within these rooms.
3. Transite bench boards found in room 138 were presumed to be asbestos containing.
4. Lex sample 12, black VFT mastic, found under most of the flooring tiles throughout the building, was found to be an asbestos containing material.
5. Lex VFT sample 13 (Olive with White Streaks 9x9) was found to be an asbestos containing material.
6. Lex VFT sample 17 (Brown with White Streaks 9x9) was found to be an asbestos containing material.
7. Lex VFT sample 18 (Grey with White Streaks 9x9) was found to be an asbestos containing material.
8. Lex VFT sample 19 (Green/Blue) was found to be an asbestos containing material.

9. Lex VFT sample 20 (White with Green Streaks 9x9) was found to be an asbestos containing material.
10. Lex VFT sample 23 (Teal with White 9x9) was found to be an asbestos containing material.
11. Lex VFT sample 25 (Grey with Black 9x9) was found to be an asbestos containing material.
12. Lex VFT sample 30 (Brown with Multi-coloured Streaks 9x9) was found to be an asbestos containing material.
13. Lex VFT sample 31(White with Brown Streaks 9x9) was found to be an asbestos containing material.
14. Lex VFT sample 32 (Blue with White 9x9) was found to be an asbestos containing material.
15. Lex VFT sample 33 (Black with White Streaks) was found to be an asbestos containing material.
16. Lex VFT sample 36 (Red with White 9x9) was found to be an asbestos containing material.
17. Lex VFT sample 39 (Army Green with White) was found to be an asbestos containing material.
18. Gold sink undercoating's were observed in rooms 209 and 209B and are presumed to be asbestos containing.
19. Fluorescent light bulbs were observed throughout the building and are presumed to be mercury containing.
20. No presence of perchlorates was found on the interior surfaces of the fume hoods.

6 Recommendations

1. Any ACM that may be disturbed during the renovation should be removed by a qualified abatement contractor prior to initiation of renovations.
2. Any lead containing materials disturbed during the renovations should be completed using the Ontario Ministry of Labour guideline *Lead on Construction Projects.*
3. It is recommended that a copy of Designated Substances Survey should be kept on-site during any renovation or demolition activities. It should also be provided to all contractors who may disturb any of the designated substances mentioned in this report.
4. Coring, sawing or breaking of materials such as concrete, brick and mortar should be considered silica-containing and should be done with appropriate dust suppression methods and proper respiratory protection and following Guideline - Silica on Construction Projects (published September 2004 and revised April 2011).
5. Any fluorescent light tubes that will be removed should be collected and disposed of by being sent to an appropriate recycling facility. Fluorescent tubes should be packed in a rigid container to mitigate any circumstances that may result in breaking of light tubes and

release of mercury vapour. Broken light tubes should also be packed in the same container for disposal.

6. Any light ballasts that will be removed should be collected from the site, checked for PCB content and disposed of by sending to an appropriate facility. LEX has a directory of ballast types and manufacturers and has staff that can assist in sorting any light ballasts removed during renovations as PCB and non-PCB containing for appropriate disposal.

7 References

1 Occupational Health and Safety Act, O. Reg 278/05 Section 18 (6) 5

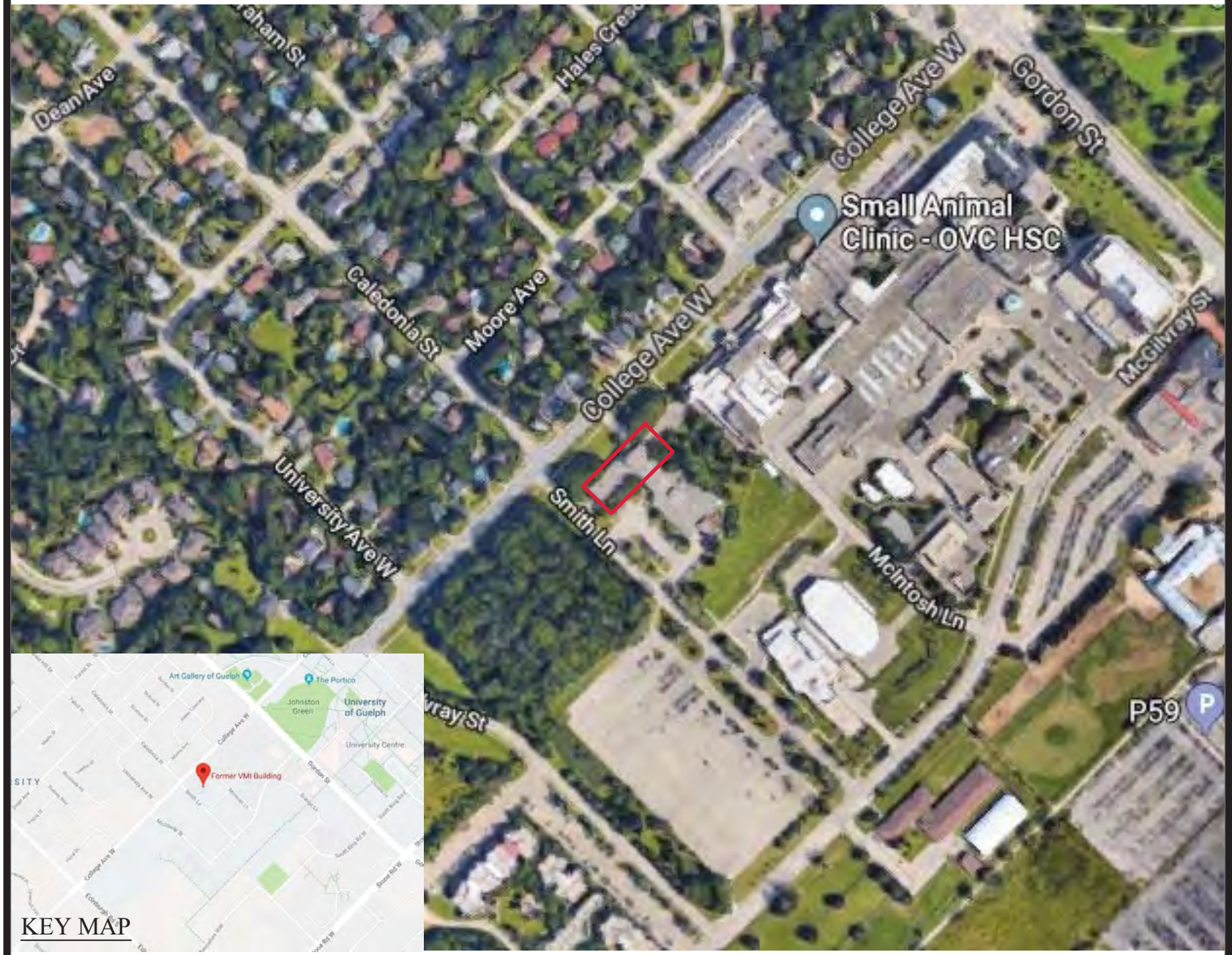
8 Disclaimer

This report is prepared exclusively for the purposes, project and site location outlined in the report. The report is based on information provided to, or collected and/or obtained by LEX as indicated in the report, and applies solely to site conditions existing at the time of sampling. LEX's report represents a reasonable analysis and interpretation of available information within an agreed scope of work, schedule and budget.

LEX's liability to the Client and all claimants not party to this agreement shall be limited to injury or loss caused by negligence of LEX and/ or sub-consultants for which it is responsible. The total amount of LEX's liability for said negligence shall be limited to the lesser of the fees paid for or actual damages incurred by the Client and the Client hereby waives all claims in excess of this amount howsoever arising including any claim for contribution and indemnity which the Client may have against LEX. The Client irrevocably and unconditionally agrees to defend, indemnify and hold LEX harmless from all claims and expenses associated therewith resulting from claims brought by other parties in excess of the aforesaid limit.

LEX prepared this report for the sole benefit of University of Guelph – Physical Resource Dept.; it reflects LEX's best judgment in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. LEX accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

Figures



KEY MAP

LEX SCIENTIFIC INC.
291 Woodlawn Road W Unit B 12
Guelph, Ontario N1H 7L6
Phone: (519) 824-7082
www.lexscientific.com

NORTH

Site Location

Not To Scale

Figure 1

Site Location Plan

Prepared By: DH

Date: June 19, 2018

Project:

Designated Substances

Survey - 01180066

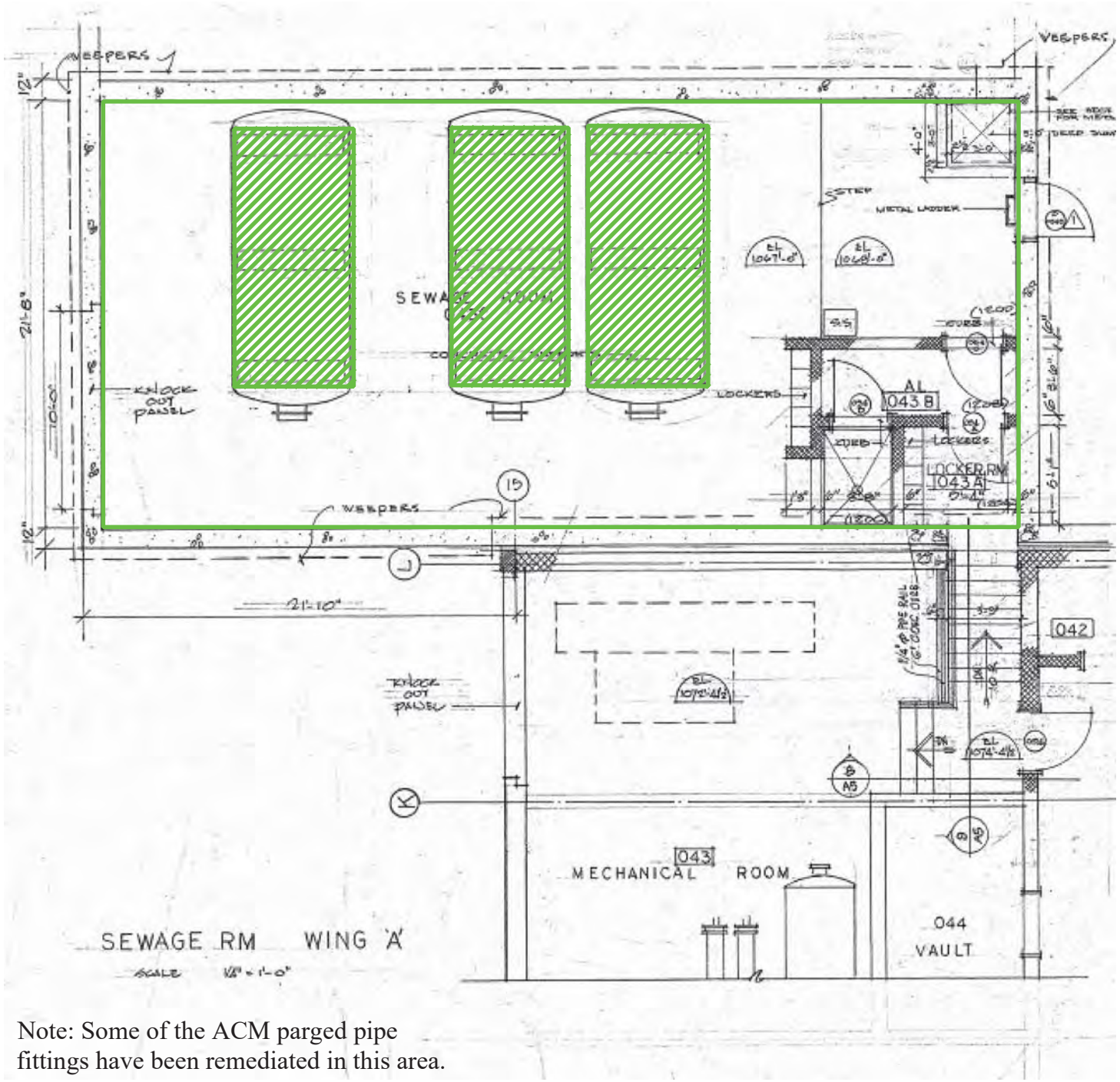
Location:

Former VMI Building

Guelph Ontario

Prepared For:

University of Guelph



NORTH

Note: Some of the ACM parged pipe fittings have been remediated in this area.

LEX SCIENTIFIC INC.
291 Woodlawn Road W Unit B 12
Guelph, Ontario N1H 7L6
Phone: (519) 824-7082
www.lexscientific.com

Legend

- Parged Boiler Tank Wrapping
- Parged Pipe Fittings Present

Not To Scale

Firgure 2

Sewage Room 120A

Asbestos Containing Materials

Prepared By: DH

Date: June 19, 2018

Project:

Designated Substances

Survey - 01180066

Location:

Former VMI Building

Guelph Ontario

Prepared For:

University of Guelph

Note: All observed VFT present within the scope of work contains ACM black mastic **except** rooms 140, and126A. For VFT sample ID refer to Appendix E.

LEX SCIENTIFIC INC.

291 Woodlawn Road W Unit B 12
Guelph, Ontario N1H 7L6
Phone: (519) 824-7082
www.lexscientific.com

Legend

- Scope of Work
- Parged Pipe Fittings Present
- Transite Bench Board Present
- ACM 9x9 VFT
- ACM 12x12 VFT

Not To Scale

Figure 3

First Floor

Asbestos Containing Materials

Prepared By: DH

Date: June 19, 2018

Project:

Designated Substances

Survey - 01180066

Location:

Fromer VMI Building

Guelph Ontario

Prepared For:

University of Guelph

Note: All observed VFT present within the scope of work contains ACM black mastic **except** room 203. For VFT sample ID refer to Appendix E.

LEX SCIENTIFIC INC.

291 Woodlawn Road W Unit B 12
Guelph, Ontario N1H 7L6
Phone: (519) 824-7082
www.lexscientific.com

Legend

- Scope of Work
- Parged Pipe Fittings Present
- ACM 9x9 VFT
- ACM 12x12 VFT

Not To Scale

Figure 4

Second Floor

Asbestos Containing Materials

Prepared By: DH

Date: June 19, 2018

Project:

Designated Substances

Survey - 01180066

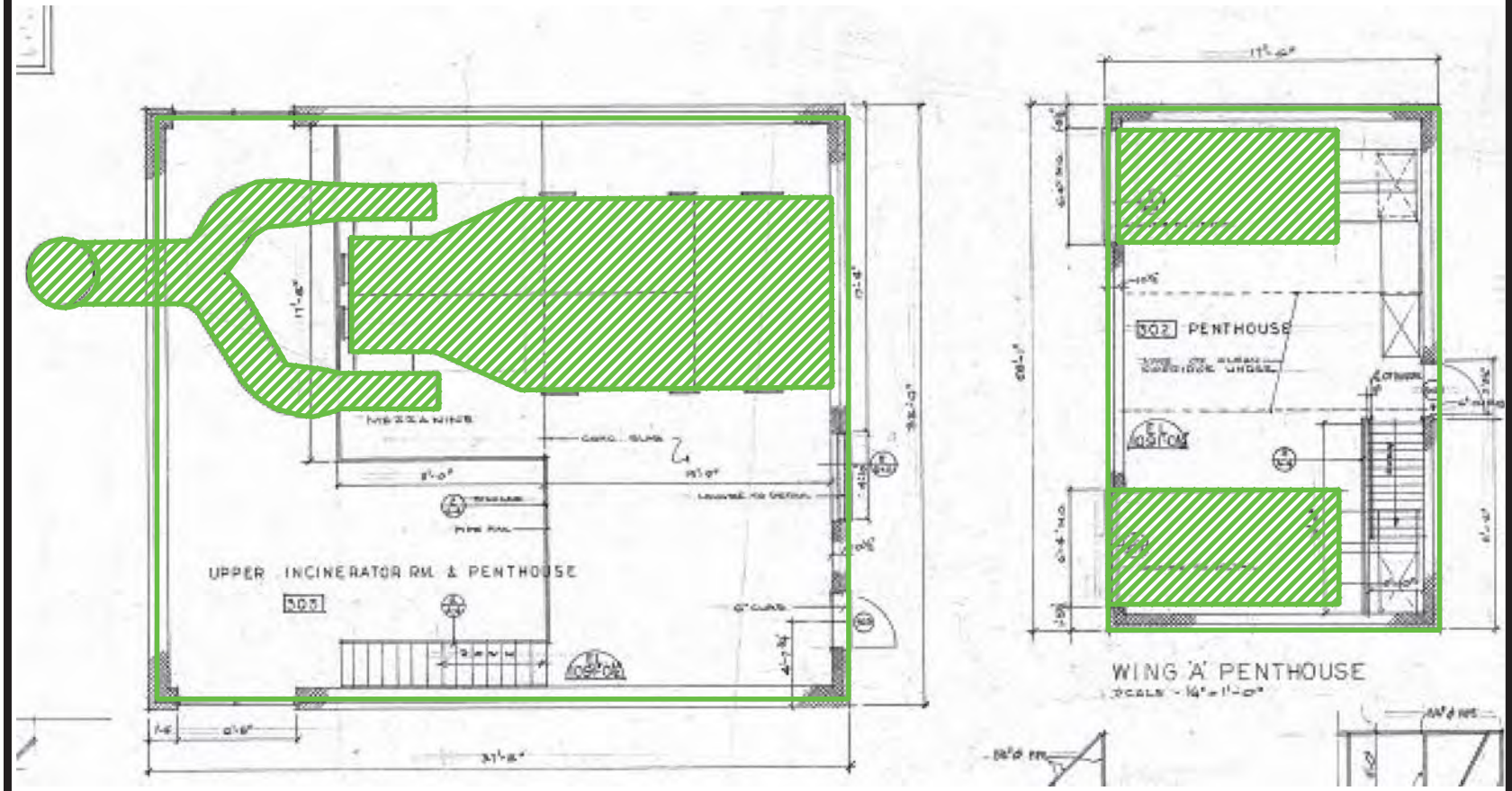
Location:

Former VMI Building

Guelph Ontario

Prepared For:

University of Guelph



Note: Additonal parged duct/insulation wrapping is present that is **not** represented in this drawing. Some of the parged pipe fittings and wrapping have been remediated in this area.

LEX SCIENTIFIC INC.
291 Woodlawn Road W Unit B 12
Guelph, Ontario N1H 7L6
Phone: (519) 824-7082
www.lexscientific.com

Legend

- Parged Duct/Insulation Wrapping
- Parged Pipe Fittings Present

Not To Scale

Figure 5

Penthouse (Mechanical Room)

Asbestos Containing Materials

Prepared By: DH

Date: June 19, 2018

Project:

Designated Substances

Survey - 01180066

Location:

Former VMI Building

Guelph Ontario

Prepared For:

University of Guelph

Appendices

Appendix A – Summary Photolog of Sampled and Noteworthy Materials

Appendix A - Summary Photolog of Sampled and Noteworthy Materials

Photo 1: Parged pipe fitting found throughout the building. **50% Chrysotile.**

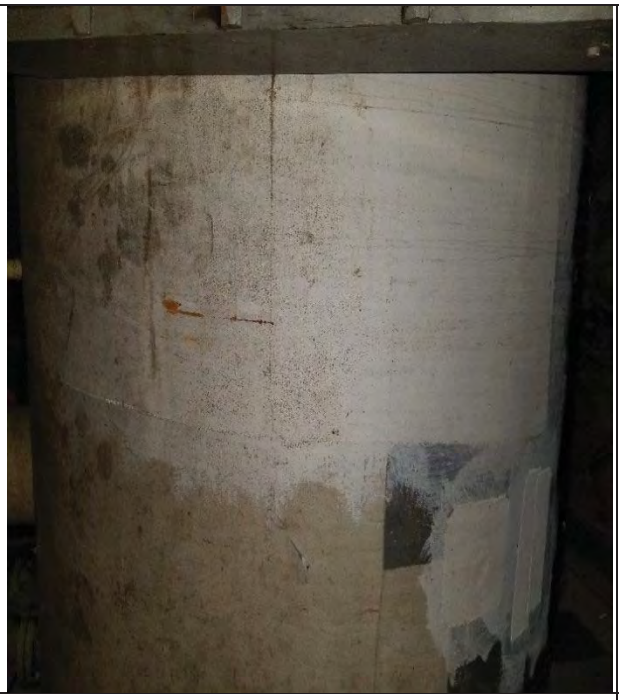


Photo 2: Parged pipe wrapping located in the Sewage Room 120A. **Presumed asbestos containing.**

Photo 3: Parged pipe wrapping located in Penthouse 222. **Presumed asbestos containing.**

Photo 4: Black VFT mastic found throughout the building. **1% Chrysotile.**

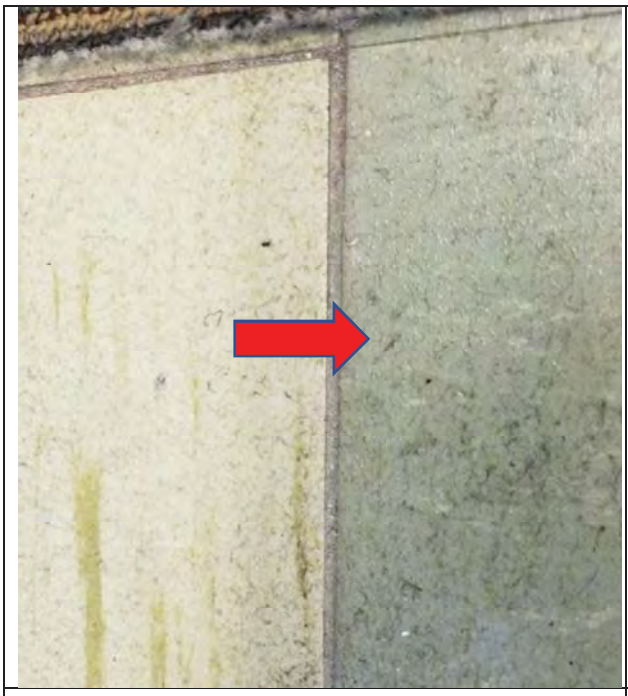


Photo 5: VFT – Teal with white streaks (Right tile, LEX sample 23). **1% Chrysotile.**

Photo 6: White with green streaks (Left tile, LEX sample 20). **2% Chrysotile.**

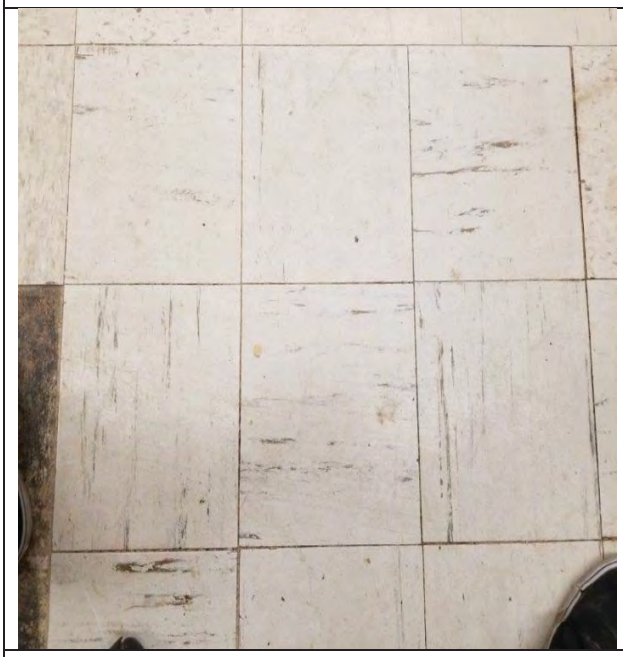


Photo 7: VFT – Grey with black streaks 9x9 (LEX sample 25). **1% Chrysotile.**

Photo 8: VFT – Brown with multi-colour streaks 9x9 (LEX sample 30). **0.5% Chrysotile.**

Photo 9: VFT – White with brown streaks 9x9 (LEX sample 31). **1% Chrysotile.**

Photo 10: VFT – Blue with white streaks 9x9 (LEX sample 32). **1% Chrysotile.**

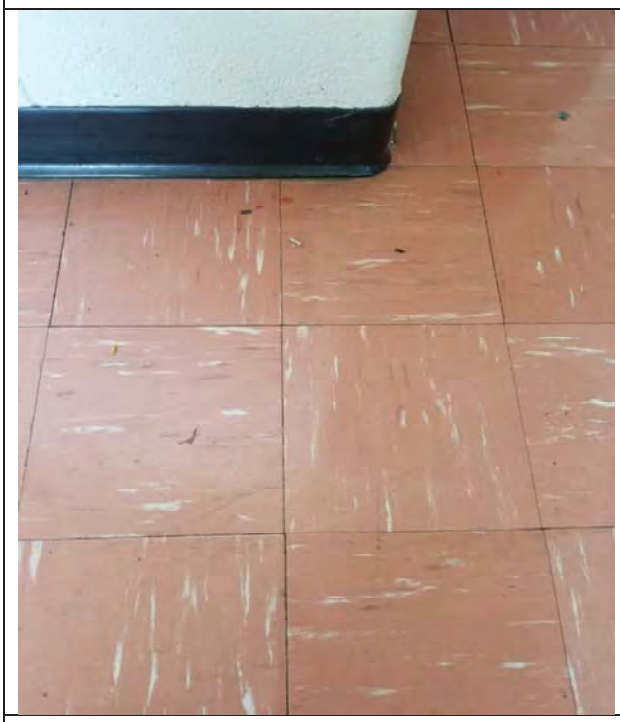


Photo 11: VFT – Red with white streaks 9x9 (LEX sample 36). **1% Chrysotile.**

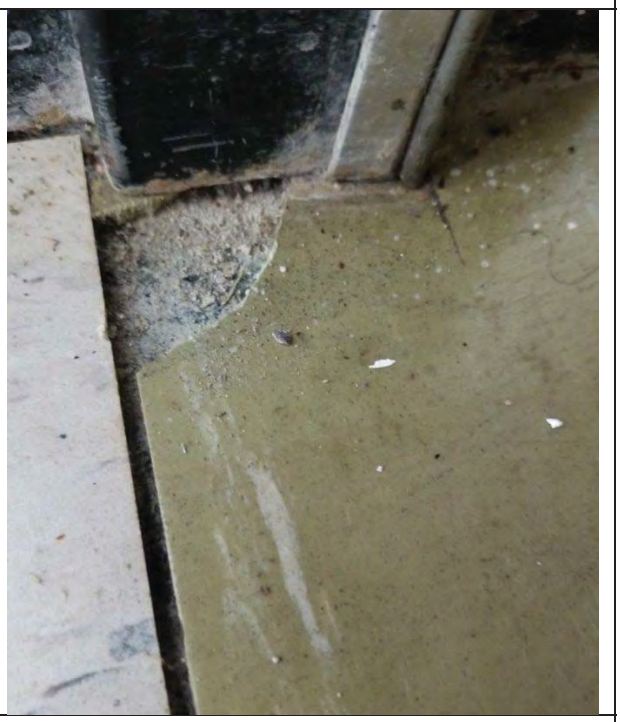


Photo 12 - VFT – Olive with white streaks 9x9 (LEX sample 13). **0.5% Chrysotile.**

Photo 13: VFT – Brown with white streaks 9x9 (LEX sample 17). **0.5% Chrysotile.**

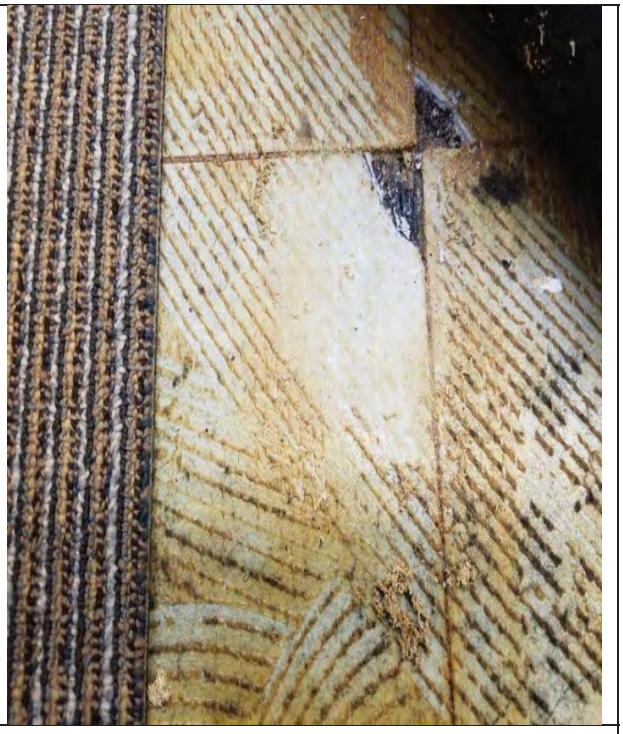


Photo 14: VFT – Grey with white 9x9 (LEX sample 18). **0.5% Chrysotile.**

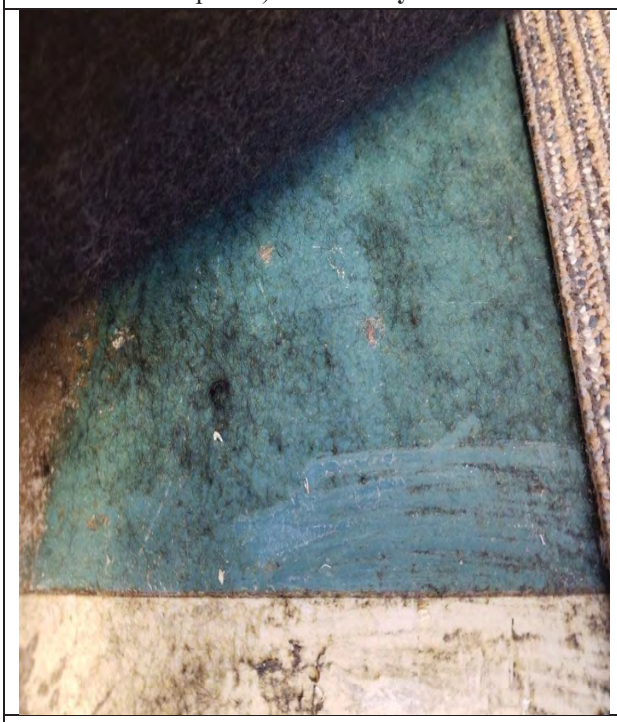


Photo 15: VFT – Green/Blue (LEX sample 19). **0.5% Chrysotile.**

Photo 16: VFT – Black with white streaks (LEX sample 33). **6% Chrysotile**

Photo 17: VFT – Army green with white (LEX sample 39). **1% Chrysotile.**

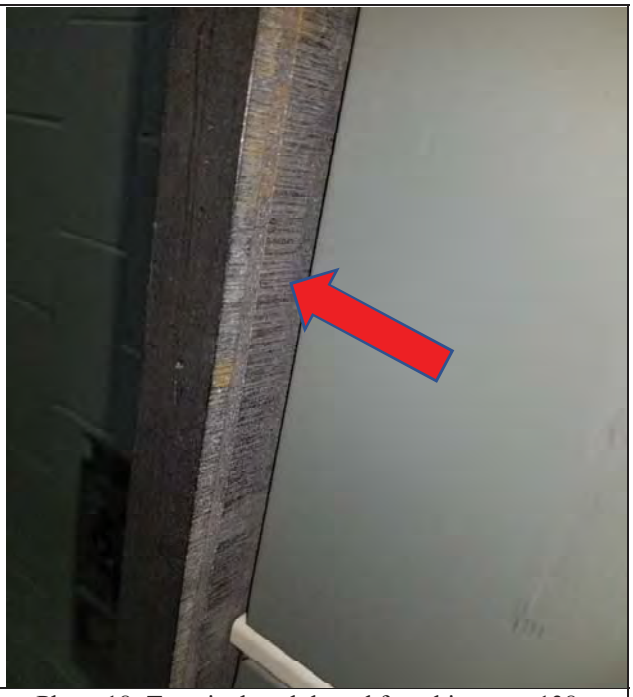


Photo 18: Transite bench board found in room 138. **Presumed asbestos containing.**

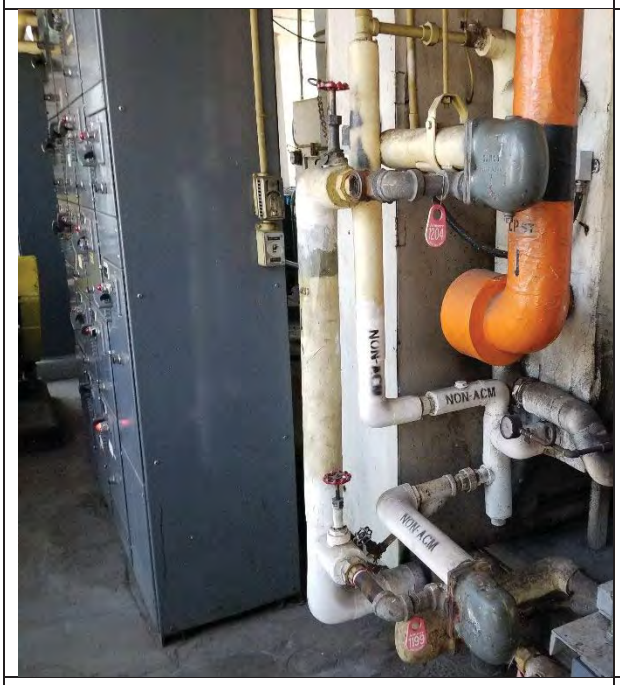


Photo 19: Parged wrapping remediation efforts observed in Penthouse 222.

Photo 20: Representative perchlorate test result completed in room 213A's fume hood. **No purple precipitates detected.**

Photo 21: Representative perchlorate test results completed in room 123's fume hood. **No purple precipitates detected.**

Appendix B – Laboratory Certificate of Analysis – Asbestos in Bulk Samples

LEX SCIENTIFIC INC.

SOLUTIONS
FOR A WORKING WORLD

CERTIFICATE OF ANALYSIS

Company:	LEX Scientific Inc.	**Report Date:**	28-May-18
Contact:	Mr. Dan Humphrey	**Analysis Date:**	24-May-18
Client Address:	291 Woodlawn Road West, Unit B-12, Guelph, ON	**Received Date:**	24-May-18
Client Reference:	01180066 University of Guelph - Physical Resource	**LEX Project Number:**	09180912
Sampling Date:	18-May-18	**Number of Analyses:**	121

Analysis Requested **Bulk Asbestos by PLM**

Analysis was performed in accordance with the method EPA/600/R-93/116, Method for the Determination of Asbestos in Bulk Building Materials adopted in Designated Substance - Asbestos on Construction Projects and in Buildings and Repair Operations - made under the Occupational Health and Safety Act Ontario Regulation 278/05. LEX Scientific Inc. is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP 101949) by the National Institute of Standards and Technology for analysis of bulk materials for asbestos.

German Leal, B.Sc.
Laboratory Manager

			Fibrous Asbestos Content %	Other Materials Content %
Client Sample:	01-A	**Asbestos Detected?**	**No**	
LEX Sample:	001.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed:	Scratch Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour:	Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description:	Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
		Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

291 Woodlawn Road West, Unit B-12, Guelph, Ontario N1H 7L6
Phone: 519.824.7082 Toll Free: 1.800.824.7082
e-mail: lab@lexscientific.com Website: www.lexscientific.com

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 01-A	**Asbestos Detected?**	**No**	
LEX Sample: 001.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Finish Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-B	**Asbestos Detected?**	**No**	
LEX Sample: 002.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Scratch Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-B	**Asbestos Detected?**	**No**	
LEX Sample: 002.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Finish Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-C	**Asbestos Detected?**	**No**	
LEX Sample: 003.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Scratch Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-C	**Asbestos Detected?**	**No**	
LEX Sample: 003.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Finish Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-D	**Asbestos Detected?**	**No**	
LEX Sample: 004.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Scratch Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

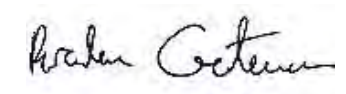
		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 01-D	**Asbestos Detected?**	**No**	
LEX Sample: 004.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Finish Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-E	**Asbestos Detected?**	**No**	
LEX Sample: 005.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Scratch Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-E	**Asbestos Detected?**	**No**	
LEX Sample: 005.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Finish Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-F	**Asbestos Detected?**	**No**	
LEX Sample: 006.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Scratch Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-F	**Asbestos Detected?**	**No**	
LEX Sample: 006.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Finish Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 01-G	**Asbestos Detected?**	**No**	
LEX Sample: 007.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Scratch Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 01-G	**Asbestos Detected?**	**No**	
LEX Sample: 007.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Finish Coat	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Plaster (Two Layer)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 02-A	**Asbestos Detected?**	**No**	
LEX Sample: 008	**Chrysotile:**	None Detected	**Cellulose:** 50
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 50
Colour: Grey/White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Large/Small Pinhole	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 02-B	**Asbestos Detected?**	**No**	
LEX Sample: 009	**Chrysotile:**	None Detected	**Cellulose:** 50
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 50
Colour: Grey/White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Large/Small Pinhole	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 02-C	**Asbestos Detected?**	**No**	
LEX Sample: 010	**Chrysotile:**	None Detected	**Cellulose:** 50
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 50
Colour: Grey/White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Large/Small Pinhole	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 03-A	**Asbestos Detected?**	**No**	
LEX Sample: 011	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile Pucks - 9x9 Glue	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 03-B	**Asbestos Detected?**	**No**	
LEX Sample: 012	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile Pucks - 9x9 Glue	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

		Fibrous Asbestos Content %		Other Materials Content %	
Client Sample:	03-C	**Asbestos Detected?**	**No**		
LEX Sample:	013	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Brown	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Ceiling Tile Pucks - 9x9 Glue	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	04-A	**Asbestos Detected?**	**No**		
LEX Sample:	014	**Chrysotile:**	None Detected	**Cellulose:**	60
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	40
Colour:	Grey/White	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Ceiling Tile - Rough	**Other Amphiboles:**	None Detected	**Non Fibrous:**	None Detected
		Comments:	N/A		
Client Sample:	04-B	**Asbestos Detected?**	**No**		
LEX Sample:	015	**Chrysotile:**	None Detected	**Cellulose:**	60
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	40
Colour:	Grey/White	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Ceiling Tile - Rough	**Other Amphiboles:**	None Detected	**Non Fibrous:**	None Detected
		Comments:	N/A		
Client Sample:	04-C	**Asbestos Detected?**	**No**		
LEX Sample:	016	**Chrysotile:**	None Detected	**Cellulose:**	60
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	40
Colour:	Grey/White	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Ceiling Tile - Rough	**Other Amphiboles:**	None Detected	**Non Fibrous:**	None Detected
		Comments:	N/A		
Client Sample:	05-A	**Asbestos Detected?**	**No**		
LEX Sample:	017	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Grey/White	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Window Caulking - White	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	05-B	**Asbestos Detected?**	**No**		
LEX Sample:	018	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Grey/White	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Window Caulking - White	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

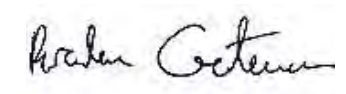
		Fibrous Asbestos Content %		Other Materials Content %	
Client Sample:	05-C	**Asbestos Detected?**	**No**		
LEX Sample:	019	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Grey/White	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Window Caulking - White	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	06-A	**Asbestos Detected?**	**No**		
LEX Sample:	020	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Mastic	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Orange	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Baseboard Mastic #1 (yellow)	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	06-B	**Asbestos Detected?**	**No**		
LEX Sample:	021	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Mastic	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Orange	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Baseboard Mastic #1 (yellow)	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	06-C	**Asbestos Detected?**	**No**		
LEX Sample:	022	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Mastic	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Orange	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Baseboard Mastic #1 (yellow)	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	07-A	**Asbestos Detected?**	**No**		
LEX Sample:	023.1	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Floor Tile	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Brown	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Brown with Grey + Mastic	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 07-A	**Asbestos Detected?**	**No**	
LEX Sample: 023.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Mastic	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Brown with Grey + Mastic	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 07-B	**Asbestos Detected?**	**No**	
LEX Sample: 024.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Floor Tile	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Brown with Grey + Mastic	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 07-B	**Asbestos Detected?**	**No**	
LEX Sample: 024.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Mastic	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Brown with Grey + Mastic	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 07-C	**Asbestos Detected?**	**No**	
LEX Sample: 025.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Floor Tile	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Brown with Grey + Mastic	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 07-C	**Asbestos Detected?**	**No**	
LEX Sample: 025.2	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Mastic	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Brown with Grey + Mastic	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

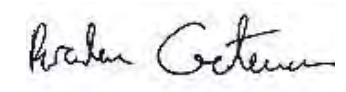
		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 08-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 026	**Chrysotile:**	50	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Parged Pipe Fitting	**Other Amphiboles:**	None Detected	**Non Fibrous:** 50
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 09-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 027	**Chrysotile:**	< 0.5	**Cellulose:** 100
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Tar Duct Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	Not asbestos containing material under Ontario Regulation 278/05.	
Client Sample: 09-B	**Asbestos Detected?**	**Yes**	
LEX Sample: 028	**Chrysotile:**	< 0.5	**Cellulose:** 100
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Tar Duct Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	Not asbestos containing material under Ontario Regulation 278/05.	
Client Sample: 09-C	**Asbestos Detected?**	**Yes**	
LEX Sample: 029	**Chrysotile:**	< 0.5	**Cellulose:** 100
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Tar Duct Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	Not asbestos containing material under Ontario Regulation 278/05.	
Client Sample: 10-A	**Asbestos Detected?**	**No**	
LEX Sample: 030	**Chrysotile:**	None Detected	**Cellulose:** 5
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Blue/Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Sink Undercoat	**Other Amphiboles:**	None Detected	**Non Fibrous:** 95
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

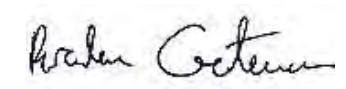
		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 10-B	**Asbestos Detected?**	**No**	
LEX Sample: 031	**Chrysotile:**	None Detected	**Cellulose:** 5
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Blue/Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Sink Undercoat	**Other Amphiboles:**	None Detected	**Non Fibrous:** 95
	Comments:	N/A	
Client Sample: 10-C	**Asbestos Detected?**	**No**	
LEX Sample: 032	**Chrysotile:**	None Detected	**Cellulose:** 5
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Blue/Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Sink Undercoat	**Other Amphiboles:**	None Detected	**Non Fibrous:** 95
	Comments:	N/A	
Client Sample: 11-A	**Asbestos Detected?**	**No**	
LEX Sample: 033	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Mastic	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Baseboard Mastic #2	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 11-B	**Asbestos Detected?**	**No**	
LEX Sample: 034	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Mastic	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Baseboard Mastic #2	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 11-C	**Asbestos Detected?**	**No**	
LEX Sample: 035	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Mastic	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Baseboard Mastic #2	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

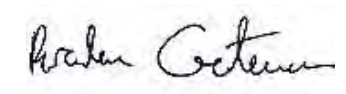
		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 12-A	**Asbestos Detected?**	**No**	
LEX Sample: 036.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Floor Tile	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White and Black and Mastic (Black)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 12-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 036.2	**Chrysotile:**	1	**Cellulose:** None Detected
Layers Analyzed: Mastic	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White and Black and Mastic (Black)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 12-B	**Asbestos Detected?**	**No**	
LEX Sample: 037.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Floor Tile	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White and Black and Mastic (Black)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 12-C	**Asbestos Detected?**	**No**	
LEX Sample: 038.1	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Floor Tile	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White and Black and Mastic (Black)	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 13-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 039	**Chrysotile:**	0.5	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Green/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Olive with White Streaks 9x9	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99.5
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 14-A	**Asbestos Detected?**	**No**	
LEX Sample: 042	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White/Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White with Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 14-B	**Asbestos Detected?**	**No**	
LEX Sample: 043	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White/Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White with Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 14-C	**Asbestos Detected?**	**No**	
LEX Sample: 044	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White/Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White with Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 15-A	**Asbestos Detected?**	**No**	
LEX Sample: 045	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Drywall Joint Filling Compound	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 15-B	**Asbestos Detected?**	**No**	
LEX Sample: 046	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Drywall Joint Filling Compound	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 15-C	**Asbestos Detected?**	**No**	
LEX Sample: 047	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Drywall Joint Filling Compound	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

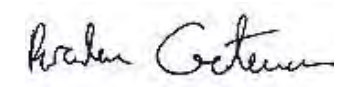
		Fibrous Asbestos Content %		Other Materials Content %	
Client Sample: 15-D	**Asbestos Detected?**	**No**			
LEX Sample: 048	**Chrysotile:**	None Detected		**Cellulose:**	None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected		**MMVF:**	None Detected
Colour: White	**Crocidolite:**	None Detected		**Other Fibres:**	None Detected
Description: Drywall Joint Filling Compound	**Other Amphiboles:**	None Detected		**Non Fibrous:**	100
	Comments:	N/A			
Client Sample: 15-E	**Asbestos Detected?**	**No**			
LEX Sample: 049	**Chrysotile:**	None Detected		**Cellulose:**	None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected		**MMVF:**	None Detected
Colour: White	**Crocidolite:**	None Detected		**Other Fibres:**	None Detected
Description: Drywall Joint Filling Compound	**Other Amphiboles:**	None Detected		**Non Fibrous:**	100
	Comments:	N/A			
Client Sample: 16-A	**Asbestos Detected?**	**No**			
LEX Sample: 050	**Chrysotile:**	None Detected		**Cellulose:**	None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected		**MMVF:**	None Detected
Colour: Orange	**Crocidolite:**	None Detected		**Other Fibres:**	None Detected
Description: Carpet Tile Mastic (Yellow)	**Other Amphiboles:**	None Detected		**Non Fibrous:**	100
	Comments:	N/A			
Client Sample: 16-B	**Asbestos Detected?**	**No**			
LEX Sample: 051	**Chrysotile:**	None Detected		**Cellulose:**	None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected		**MMVF:**	None Detected
Colour: Orange	**Crocidolite:**	None Detected		**Other Fibres:**	None Detected
Description: Carpet Tile Mastic (Yellow)	**Other Amphiboles:**	None Detected		**Non Fibrous:**	100
	Comments:	N/A			
Client Sample: 16-C	**Asbestos Detected?**	**No**			
LEX Sample: 052	**Chrysotile:**	None Detected		**Cellulose:**	None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected		**MMVF:**	None Detected
Colour: Orange	**Crocidolite:**	None Detected		**Other Fibres:**	None Detected
Description: Carpet Tile Mastic (Yellow)	**Other Amphiboles:**	None Detected		**Non Fibrous:**	100
	Comments:	N/A			

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 17-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 053	**Chrysotile:**	0.5	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Brown with White Streaks 9x9	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99.5
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 18-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 056	**Chrysotile:**	0.5	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey/Black/Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile Grey with White Streaks 9x9	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99.5
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 19-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 059	**Chrysotile:**	0.5	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Blue/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Green/Blue	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99.5
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 20-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 062	**Chrysotile:**	2	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: White/Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - White with Green Streaks	**Other Amphiboles:**	None Detected	**Non Fibrous:** 98
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 21-A	**Asbestos Detected?**	**No**	
LEX Sample: 065	**Chrysotile:**	None Detected	**Cellulose:** 10
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Leveling Compound - Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 90
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

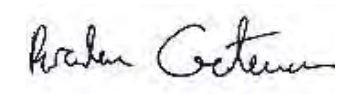
			Fibrous Asbestos Content %		Other Materials Content %
Client Sample:	21-B	**Asbestos Detected?**	**No**		
LEX Sample:	066	**Chrysotile:**	None Detected	**Cellulose:**	10
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Grey	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Leveling Compound - Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:**	90
		Comments:	N/A		
Client Sample:	21-C	**Asbestos Detected?**	**No**		
LEX Sample:	067	**Chrysotile:**	None Detected	**Cellulose:**	10
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Grey	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Leveling Compound - Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:**	90
		Comments:	N/A		
Client Sample:	22-A	**Asbestos Detected?**	**No**		
LEX Sample:	068	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	White/Orange	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Flexible Pipe Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	22-B	**Asbestos Detected?**	**No**		
LEX Sample:	069	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	White/Orange	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Flexible Pipe Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	22-C	**Asbestos Detected?**	**No**		
LEX Sample:	070	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	White/Orange	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Flexible Pipe Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

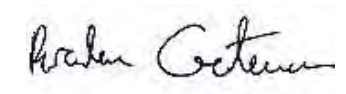
		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 23-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 071	**Chrysotile:**	1	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Blue/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - red with White 9x9	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 24-A	**Asbestos Detected?**	**No**	
LEX Sample: 074	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Beige/Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile Beige with Brown	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 24-B	**Asbestos Detected?**	**No**	
LEX Sample: 075	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Beige/Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile Beige with Brown	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 24-C	**Asbestos Detected?**	**No**	
LEX Sample: 076	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Beige/Brown	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile Beige with Brown	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 25-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 077	**Chrysotile:**	1	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Grey with Black 9x9	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

			Fibrous Asbestos Content %		Other Materials Content %
Client Sample:	26-A	**Asbestos Detected?**	**No**		
LEX Sample:	080	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Beige/Black	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Oatmeal Pattern	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	26-B	**Asbestos Detected?**	**No**		
LEX Sample:	081	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Beige/Black	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Oatmeal Pattern	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	26-C	**Asbestos Detected?**	**No**		
LEX Sample:	082	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Beige/Black	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Oatmeal Pattern	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	27-A	**Asbestos Detected?**	**No**		
LEX Sample:	083	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Purple	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Purple with White speckles	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	27-B	**Asbestos Detected?**	**No**		
LEX Sample:	084	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Purple	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Purple with White speckles	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

		Fibrous Asbestos Content %		Other Materials Content %	
Client Sample:	27-C	**Asbestos Detected?**	**No**		
LEX Sample:	085	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Purple	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Purple with White speckles	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	28-A	**Asbestos Detected?**	**No**		
LEX Sample:	086	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Beige	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Undersink Coating - White	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	28-B	**Asbestos Detected?**	**No**		
LEX Sample:	087	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Beige	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Undersink Coating - White	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	28-C	**Asbestos Detected?**	**No**		
LEX Sample:	088	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Beige	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Undersink Coating - White	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	29-A	**Asbestos Detected?**	**No**		
LEX Sample:	089	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Beige	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Cream	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %	Other Materials Content %

Client Sample: 29-B
LEX Sample: 090
Layers Analyzed: Sample Homogenized
Colour: Beige
Description: Vinyl Flooring Tile - Cream

Asbestos Detected? No

Chrysotile:	None Detected	**Cellulose:**	None Detected
Amosite:	None Detected	**MMVF:**	None Detected
Crocidolite:	None Detected	**Other Fibres:**	None Detected
Other Amphiboles:	None Detected	**Non Fibrous:**	100

Comments: N/A

Client Sample: 29-C
LEX Sample: 091
Layers Analyzed: Sample Homogenized
Colour: Beige
Description: Vinyl Flooring Tile - Cream

Asbestos Detected? No

Chrysotile:	None Detected	**Cellulose:**	None Detected
Amosite:	None Detected	**MMVF:**	None Detected
Crocidolite:	None Detected	**Other Fibres:**	None Detected
Other Amphiboles:	None Detected	**Non Fibrous:**	100

Comments: N/A

Client Sample: 30-A
LEX Sample: 092
Layers Analyzed: Sample Homogenized
Colour: Brown
Description: Vinyl Flooring Tile - Brown with Multicolour Streaks 9x9

Asbestos Detected? Yes

Chrysotile:	0.5	**Cellulose:**	None Detected
Amosite:	None Detected	**MMVF:**	None Detected
Crocidolite:	None Detected	**Other Fibres:**	None Detected
Other Amphiboles:	None Detected	**Non Fibrous:**	99.5

Comments: This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.

Client Sample: 31-A
LEX Sample: 095
Layers Analyzed: Sample Homogenized
Colour: Grey
Description: Vinyl Flooring Tile - White with Brown Streaks 9x9

Asbestos Detected? Yes

Chrysotile:	1	**Cellulose:**	None Detected
Amosite:	None Detected	**MMVF:**	None Detected
Crocidolite:	None Detected	**Other Fibres:**	None Detected
Other Amphiboles:	None Detected	**Non Fibrous:**	99

Comments: This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.

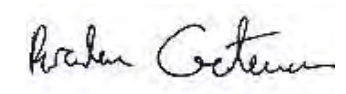
Client Sample: 32-A
LEX Sample: 098
Layers Analyzed: Sample Homogenized
Colour: Blue/White
Description: Vinyl Flooring Tile - Blue with White Streaks 9x9

Asbestos Detected? Yes

Chrysotile:	0.5	**Cellulose:**	None Detected
Amosite:	None Detected	**MMVF:**	None Detected
Crocidolite:	None Detected	**Other Fibres:**	None Detected
Other Amphiboles:	None Detected	**Non Fibrous:**	99.5

Comments: This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

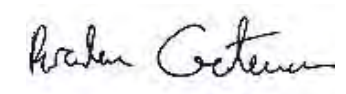
		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 33-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 101	**Chrysotile:**	6	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Black with Black Streaks 9x9	**Other Amphiboles:**	None Detected	**Non Fibrous:** 94
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 34-A	**Asbestos Detected?**	**No**	
LEX Sample: 104	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Grey with Black Streaks	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 34-B	**Asbestos Detected?**	**No**	
LEX Sample: 105	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Grey with Black Streaks	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 34-C	**Asbestos Detected?**	**No**	
LEX Sample: 106	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Grey with Black Streaks	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 35-A	**Asbestos Detected?**	**No**	
LEX Sample: 107	**Chrysotile:**	None Detected	**Cellulose:** 60
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 40
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Bumps with Pinholes 2x4	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 35-B	**Asbestos Detected?**	**No**	
LEX Sample: 108	**Chrysotile:**	None Detected	**Cellulose:** 60
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 40
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Bumps with Pinholes 2x4	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 35-C	**Asbestos Detected?**	**No**	
LEX Sample: 109	**Chrysotile:**	None Detected	**Cellulose:** 60
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 40
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Bumps with Pinholes 2x4	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 36-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 110	**Chrysotile:**	1	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Red/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Red with White Streaks 9x9	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	
Client Sample: 37-A	**Asbestos Detected?**	**No**	
LEX Sample: 113	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Red/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Orange/Red	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 37-B	**Asbestos Detected?**	**No**	
LEX Sample: 114	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Red/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Orange/Red	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 37-C	**Asbestos Detected?**	**No**	
LEX Sample: 115	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Red/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Orange/Red	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 38-A	**Asbestos Detected?**	**No**	
LEX Sample: 116	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Red/Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Dark Multicolour Red	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 38-B	**Asbestos Detected?**	**No**	
LEX Sample: 117	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Red/Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Dark Multicolour Red	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 38-C	**Asbestos Detected?**	**No**	
LEX Sample: 118	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Red/Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Dark Multicolour Red	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 39-A	**Asbestos Detected?**	**Yes**	
LEX Sample: 119	**Chrysotile:**	1	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Green/Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Army Green with White	**Other Amphiboles:**	None Detected	**Non Fibrous:** 99
	Comments:	This sample meets the definition of "asbestos containing material" according to Ontario Regulation 278/05.	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 40-A	**Asbestos Detected?**	**No**	
LEX Sample: 122	**Chrysotile:**	None Detected	**Cellulose:** 60
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 40
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Texture with pinholes + fissures 2x2	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 40-B	**Asbestos Detected?**	**No**	
LEX Sample: 123	**Chrysotile:**	None Detected	**Cellulose:** 60
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 40
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Texture with pinholes + fissures 2x2	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 40-C	**Asbestos Detected?**	**No**	
LEX Sample: 124	**Chrysotile:**	None Detected	**Cellulose:** 60
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** 40
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Ceiling Tile - Texture with pinholes + fissures 2x2	**Other Amphiboles:**	None Detected	**Non Fibrous:** None Detected
	Comments:	N/A	
Client Sample: 41-A	**Asbestos Detected?**	**No**	
LEX Sample: 125	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Black Pipe Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 41-B	**Asbestos Detected?**	**No**	
LEX Sample: 126	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Black Pipe Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

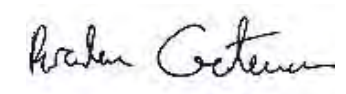
		Fibrous Asbestos Content %	Other Materials Content %
Client Sample: 41-C	**Asbestos Detected?**	**No**	
LEX Sample: 127	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Black	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Black Pipe Insulation	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 42-A	**Asbestos Detected?**	**No**	
LEX Sample: 128	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Multi-Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 42-B	**Asbestos Detected?**	**No**	
LEX Sample: 129	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Multi-Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 42-C	**Asbestos Detected?**	**No**	
LEX Sample: 130	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Tile - Multi-Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 43-A	**Asbestos Detected?**	**No**	
LEX Sample: 131	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey/Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Sheet - Dark Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	
Client Sample: 43-B	**Asbestos Detected?**	**No**	
LEX Sample: 132	**Chrysotile:**	None Detected	**Cellulose:** None Detected
Layers Analyzed: Sample Homogenized	**Amosite:**	None Detected	**MMVF:** None Detected
Colour: Grey/Orange	**Crocidolite:**	None Detected	**Other Fibres:** None Detected
Description: Vinyl Flooring Sheet - Dark Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:** 100
	Comments:	N/A	

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst

		Fibrous Asbestos Content %		Other Materials Content %	
Client Sample:	43-C	**Asbestos Detected?**	**No**		
LEX Sample:	133	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Grey/Orange	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Sheet - Dark Grey	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	44-A	**Asbestos Detected?**	**No**		
LEX Sample:	134	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Brown	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Tan + Brown	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	44-B	**Asbestos Detected?**	**No**		
LEX Sample:	135	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Brown	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Tan + Brown	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		
Client Sample:	44-C	**Asbestos Detected?**	**No**		
LEX Sample:	136	**Chrysotile:**	None Detected	**Cellulose:**	None Detected
Layers Analyzed:	Sample Homogenized	**Amosite:**	None Detected	**MMVF:**	None Detected
Colour:	Brown	**Crocidolite:**	None Detected	**Other Fibres:**	None Detected
Description:	Vinyl Flooring Tile - Tan + Brown	**Other Amphiboles:**	None Detected	**Non Fibrous:**	100
		Comments:	N/A		

Other Amphiboles: ac=actinolite, a=anthophyllite, t-tremolite, u=unidentified
MMVF: Man Made Vitreous Fibres: Fibreglass, Min. Wool, Rockwool, Glasswool
PLM - method detection limit is 0.1%

Analyst 

Appendix C – Laboratory Certificate of Analysis – Lead in Paint Chip Samples

Your P.O. #: 530472
Your Project #: 01180066
Your C.O.C. #: nz

Attention: Dan Humphrey

Lex Scientific Inc
291 Woodlawn Rd W
Unit B12
Guelph, ON
CANADA N1H 7L6

Report Date: 2018/05/30
Report #: R5184076
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8C2991
Received: 2018/05/24, 15:30

Sample Matrix: Paint
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Metals in Paint	2	2018/05/25	2018/05/25	CAM SOP-00408	EPA 6010D 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.

Your P.O. #: 530472
Your Project #: 01180066
Your C.O.C. #: nz

Attention: Dan Humphrey

Lex Scientific Inc
291 Woodlawn Rd W
Unit B12
Guelph, ON
CANADA N1H 7L6

Report Date: 2018/05/30
Report #: R5184076
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8C2991
Received: 2018/05/24, 15:30

Encryption Key

Maxxam
30 May 2018 11:47:40

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Nazeema Rahaman, Project Manager
Email: NRahaman@maxxam.ca
Phone# (905) 817-5700
==========
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 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B8C2991
Report Date: 2018/05/30

Lex Scientific Inc
Client Project #: 01180066
Your P.O. #: 530472
Sampler Initials: LEX

ELEMENTS BY ATOMIC SPECTROSCOPY (PAINT)

Maxxam ID		GTU598		GTU599		
Sampling Date		2018/05/18		2018/05/18		
COC Number		nz		nz		
	UNITS	L-01 GREY PAINT	RDL	L-02 BEIGE PAINT	RDL	QC Batch
Metals						
Lead (Pb)	mg/kg	2600	11	290	10	5547822

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B8C2991
Report Date: 2018/05/30

Lex Scientific Inc
Client Project #: 01180066
Your P.O. #: 530472
Sampler Initials: LEX

TEST SUMMARY

Maxxam ID: GTU598
Sample ID: L-01 GREY PAINT
Matrix: Paint

Collected: 2018/05/18
Shipped:
Received: 2018/05/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Metals in Paint	ICP	5547822	2018/05/25	2018/05/25	Suban Kanapathippllai

Maxxam ID: GTU599
Sample ID: L-02 BEIGE PAINT
Matrix: Paint

Collected: 2018/05/18
Shipped:
Received: 2018/05/24

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Metals in Paint	ICP	5547822	2018/05/25	2018/05/25	Suban Kanapathippllai

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Maxxam Job #: B8C2991
Report Date: 2018/05/30

Lex Scientific Inc
Client Project #: 01180066
Your P.O. #: 530472
Sampler Initials: LEX

GENERAL COMMENTS

Sample GTU598 [L-01 GREY PAINT] : Metals Analysis: Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.

Sample GTU599 [L-02 BEIGE PAINT] : Metals Analysis: Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.

Results relate only to the items tested.

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Maxxam Job #: B8C2991
Report Date: 2018/05/30

Lex Scientific Inc
Client Project #: 01180066
Your P.O. #: 530472
Sampler Initials: LEX

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
5547822	SUK	Matrix Spike	Lead (Pb)	2018/05/25		NC	%	75 - 125
5547822	SUK	QC Standard	Lead (Pb)	2018/05/25		100	%	75 - 125
5547822	SUK	Method Blank	Lead (Pb)	2018/05/25	ND, RDL=1.0		mg/kg	
5547822	SUK	RPD	Lead (Pb)	2018/05/25	3.7		%	35

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

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 (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

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Maxxam Job #: B8C2991
Report Date: 2018/05/30

Lex Scientific Inc
Client Project #: 01180066
Your P.O. #: 530472
Sampler Initials: LEX

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Brad Newman, Scientific Service 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.

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Maxxam

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/3

CHAIN OF CUSTODY RECORD

Page 1 of 1

Invoice Information

Company Name: LEX Scientific Inc.
Contact Name: Berni Hosking
Address: 291 Woodlawn Road West, Unit B-12, Guelph, ON N1H 7L6
Phone: 519-824-7082 Fax:
Email: ar@lexscientific.com

Report Information (if differs from invoice)

Company Name: LEX
Contact Name: Don Humphrey
Address:
Phone: Fax:
Email: dhumphrey@lexscientific.com

Project Information (where applicable)

Quotation #:
P.O. #/ AFE#: 530472
Project #: C1180066
Site Location:
Site #:
Sampled By: LEX

Turnaround Time (TAT) Required

☑ Regular TAT (5-7 days) Most analyses

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied) ☐ 1 Day ☐ 2 Days ☐ 3-4 Days

Date Required:

Rush Confirmation #:

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ Table ___

FOR RSC (PLEASE CIRCLE) Y / N

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ MISA ☐ Storm Sewer Bylaw
☐ PWQO Region
☐ Other (Specify)
☐ REG 558 (MIN. 3 DAY TAT REQUIRED)

Include Criteria on Certificate of Analysis: Y / N

SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

Analysis Requested

#	SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / Cr VI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	Lead In Paint								HOLD - DO NOT ANALYZE	COMMENTS
1	L-01 Grey Paint	2018/05/18		Paint									X									
2	L-02 Beige Paint	2018/05/18		Paint									X									
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

24-May-18 15:30
Nazeema Rahaman
B8C2991
GK1 ENV-602

LABORATORY USE ONLY

CUSTODY SEAL Y / N		COOLER TEMPERATURES
Present	Intact	

COOLING MEDIA PRESENT: Y / N

RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #
D. HUMPHREY	2018/05/22		[illegible signature]	2018/05/24	15:30	

Appendix D – Asbestos Quantification and Management Form

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
1		128	Insulation	Asbestos	Parged pipe fitting	08	3	units	Good	Yes	Limited view. Likely more above ceiling
1		129	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Unable to view above ceiling
1		130	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	Limited view. Likely more above ceiling
1	132	132	Insulation	Asbestos	Parged pipe fitting	08	6	units	Good	Yes	Limited view. Likely more above ceiling
1	132A	132	Insulation	Asbestos	Parged pipe fitting	08		units	Good	Yes	Unable to view above ceiling
1	132B	132	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Unable to view above ceiling
1	132C	132	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Unable to view above ceiling
1		133	Insulation	Asbestos	Parged pipe fitting	08	23	units	Good	Yes	Limited view. Likely more above ceiling
1		135	Insulation	Asbestos	Parged pipe fitting	08	10	units	Good	No	Limited view. Likely more above ceiling
1		138	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	Limited view. Likely more above ceiling
1	138A	138	Insulation	Asbestos	Parged pipe fitting	08	6	units	Good	Yes	Limited view. Likely more above ceiling
1	138B	138	Insulation	Asbestos	Parged pipe fitting	08	7	units	Good	Yes	Limited view. Likely more above ceiling
1		139	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	Limited view. Likely more above ceiling
1	139A	139	Insulation	Asbestos	Parged pipe fitting	08	7	units	Good	Yes	
1	140A	140	Insulation	Asbestos	Parged pipe fitting	08	22	units	Good	Yes	
1	Washroom		Insulation	Asbestos	Parged pipe fitting	08	6	units	Good	Yes	
1	Washroom	116	Insulation	Asbestos	Parged pipe fitting	08	22	units	Good	Yes	Above room and inside wall cavity
1	Washroom	117	Insulation	Asbestos	Parged pipe fitting	08	9	units	Good	Yes	Limited view. Likely more above ceiling
1	117A, 117B	117	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Limited view. Likely more above ceiling
1		119	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	Unable to view above ceiling.

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
1	120A	120	Insulation	Asbestos	Parged pipe fitting	08	80	units	Good	Yes	Some remediation observed
1	120A	120	Insulation	Asbestos	Parged pipe fitting	08	10	units	Fair	Yes	
1	120A	120	Insulation	Asbestos	Parged boiler tanks	08	3	units	Fair	Yes	Some remediation observed
1		121	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Unable to view above ceiling
1		123	Insulation	Asbestos	Parged pipe fitting	08	11	units	Good	Yes	Limited view. Likely more above ceiling
1	125B	125	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	Behind sink (room 125A)
1	125A	125	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	
1		126	Insulation	Asbestos	Parged pipe fitting	08	15	units	Good	Yes	Limited view. Likely more above ceiling
1	126D	126	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Limited view. Likely more above ceiling
1	126E	126	Insulation	Asbestos	Parged pipe fitting	08	9	units	Good	No	
1	126A	126	Insulation	Asbestos	Parged pipe fitting	08	5	units	Good	Yes	
1		127	Insulation	Asbestos	Parged pipe fitting	08	10	units	Good	Yes	Limited view. Likely more above ceiling
1	MW116		Insulation	Asbestos	Parged pipe fitting	08	7	units	Good	Yes	Limited view. Likely more above ceiling
1	101	101	Insulation	Asbestos	Parged pipe fitting	08	10	units	Good	Yes	
1	109, 109A, 109B	109	Insulation	Asbestos	Parged pipe fitting	08	10	units	Good	Yes	Limited view. Likely more above ceiling
3	Penthouse mechanical room	222	Insulation	Asbestos	Parged pipe wrapping	08	1200	sq ft	Good	Yes	Found on circular ducting
3	Penthouse mechanical room	222	Insulation	Asbestos	Parged pipe fitting	08	20	units	Good	Yes	Part of ducting systems has not been remediated
3	Penthouse mechanical room	222	Insulation	Asbestos	Parged pipe wrapping	08	1100	sq ft	Good	Yes	Wrapped around rectangular ducting
3	Penthouse mechanical room	222	Insulation	Asbestos	Parged pipe wrapping	08	1300	sq ft	Good	Yes	Wrapped around air handling units
2		223	Insulation	Asbestos	Parged pipe fitting	08	7	units	Good	Yes	
1		102	Insulation	Asbestos	Parged pipe fitting	08	4	units	Good	Yes	Limited view behind sink area

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
1	C102	102	Insulation	Asbestos	Parged pipe fitting	08	16	units	Good	Yes	Limited view. Count approx. Evidence of some elbows mitigated (approx. 10)
1	C103	103	Insulation	Asbestos	Parged pipe fitting	08	30	units	Good	No	Limited view. Likely more above ceiling
1	113A	113	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	Limited view behind sink area
1		128	Insulation	Asbestos	Parged pipe fitting	08	2	units	Good	Yes	Limited view behind sink area
1	124	124	Ceiling	Asbestos	Parged pipe fitting	08	9	units	Good	Yes	Limited view above ceiling and behind sink area
2	Men's washroom	202	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Unable to view above ceiling
2		201	Insulation	Asbestos	Parged pipe fitting	08		units		Yes	Unable to view above ceiling
2		203	Insulation	Asbestos	Parged pipe fitting	08	6	units	Good	Yes	
2	204B	204	Insulation	Asbestos	Parged pipe fitting	08	10	units	Good	Yes	
2	206B, 206C	206	Insulation	Asbestos	Parged pipe fitting	08	3	units	Good	Yes	Limited view. Likely more above ceiling
2	209, 209A	209	Insulation	Asbestos	Parged pipe fitting	08	8	units	Good	Yes	Limited view behind sink area
2	C201		Insulation	Asbestos	Parged pipe fitting	08	14	units	Good	Yes	Limited view. Likely more above ceiling
1		130	Floor	Asbestos	Mastic - black	12	150	sq ft	Good	No	Beneath carpet tiles
1		137	Floor	Asbestos	Mastic - black	12	35	sq ft	Fair	No	No tile present, same mastic
1		138	Floor	Asbestos	VFT - white with black + mastic - black	12	220	sq ft	Good	No	
1		127	Floor	Asbestos	VFT - white with black + mastic - black	12	540	sq ft	Good	No	Beneath carpet tiles
1	106, 106A, 106B	106	Floor	Asbestos	Mastic - black	12	300	sq ft	Good	No	No tile present, same mastic
1		107	Floor	Asbestos	Mastic - black	12	170	sq ft	Good	No	No tile present, same mastic
1		115	Floor	Asbestos	VFT - white with black + mastic - black	12	126	sq ft	Good	No	
2	204	204	Floor	Asbestos	Mastic - black	12	300	sq ft	Good	No	No tile present, same mastic

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
2	205A, 205B	205	Floor	Asbestos	Mastic - black	12	472	sq ft	Good	No	No tile present, same mastic
2	206B, 206C	206	Floor	Asbestos	Mastic - black	12	104	sq ft	Good	No	No tile present, same mastic
1	138-A	138	Floor	Asbestos	VFT - 9x9 olive with white streaks + mastic - black	13	30	sq ft	Good	No	
1	138-B	138	Floor	Asbestos	VFT - 9x9 olive with white streaks + mastic - black	13	32	sq ft	Good	No	
2	215,215A,215B	215	Floor	Asbestos	VFT - 9x9 olive with white streaks + mastic - black	13	192	sq ft	Good	No	Beneath carpet tiles
2	215D,215C,216	216	Floor	Asbestos	VFT - 9x9 olive with white streaks + mastic - black	13	230	sq ft	Good	No	Beneath carpet tiles
2	218, 218A, 218B, 218C	218	Floor	Asbestos	VFT - 9x9 olive with white streaks + mastic - black	13	256	sq ft	Good	No	
1		112	Floor	Asbestos	VFT - 9x9 olive with white streaks + mastic - black	13	36	sq ft	Good	No	
2	C201		Floor	Asbestos	VFT - 9x9 olive with white streaks + mastic - black	13	80	sq ft	Good	No	
1	138-B	138	Floor	Asbestos	VFT -white with grey + mastic - black	14	18	sq ft	Good	No	
1		126	Floor	Asbestos	VFT -white with grey + mastic - black	14	270	sq ft	Good	No	Beneath carpet tiles
1	126E	126	Floor	Asbestos	VFT -white with grey + mastic - black	14	121	sq ft	Good	No	Beneath carpet tiles
1	Staff washroom	109	Floor	Asbestos	VFT -white with grey + mastic - black	14	28	sq ft	Good	No	
1	113A	113	Floor	Asbestos	VFT -white with grey + mastic - black	14	30	sq ft	Good	No	
1		128	Floor	Asbestos	VFT -white with grey + mastic - black	14	10	sq ft	Good	No	Any other flooring not quantified due to large proportional differences
2	204B	204	Floor	Asbestos	VFT -white with grey + mastic - black	14	15	sq ft	Good	No	

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
2	207, 207B	207	Floor	Asbestos	VFT -white with grey + mastic - black	14	15	sq ft	Good	No	
1	132A	132	Floor	Asbestos	VFT - 9x9 brown with white streaks + mastic - black	17	144	sq ft	Good	No	Beneath carpet tiles
2		221	Floor	Asbestos	VFT - 9x9 brown with white streaks + mastic - black	17	276	sq ft	Good	No	Beneath carpet tiles
3	Penthouse mechanical room	222	Floor	Asbestos	VFT - 9x9 brown with white streaks + mastic - black	17	16	sq ft	Good	No	
2	209, 209A	209	Floor	Asbestos	VFT - 9x9 brown with white streaks + mastic - black	17	96	sq ft	Good	No	
2	210, 210A, 210B, 210C	210	Floor	Asbestos	VFT - 9x9 brown with white streaks + mastic - black	17	80	sq ft	Good	No	
1		128	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	200	sq ft	Good	No	
1	117A	117	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	143	sq ft	Good	No	Beneath carpet tiles
1	117B	117	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	121	sq ft	Good	No	
1	125B	125	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	60	sq ft	Good	No	Pooling water
1	125A	125	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	216	sq ft	Fair	No	
1		125	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	24	sq ft	Good	No	
1	126D	126	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	60	sq ft	Good	No	Beneath carpet tiles
1	126B	126	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	143	sq ft	Good	No	Beneath carpet tiles
2	214A,B	214	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	242	sq ft	Good	No	Beneath carpet tiles
2	215, 215A, 215B	215	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	121	sq ft	Good	No	Beneath carpet tiles

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
1		111	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	300	sq ft	Good	No	
2		203	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	215	sq ft	Good	No	Beneath carpet tiles.
2	203A	203	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	88	sq ft	Good	No	Beneath carpet tiles
2	206B, 206C	206	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	10	sq ft	Good	No	
2	206A	206	Floor	Asbestos	VFT - 9x9 grey with white streaks + mastic - black	18	280	sq ft	Good	No	
1		126	Floor	Asbestos	VFT - green/blue + mastic - black	19	270	sq ft	Good	No	Beneath carpet tiles
1	132B	132	Floor	Asbestos	VFT - 9x9 white with green + mastic - black	20	130	sq ft	Good	No	Beneath carpet tiles
1	126D	126	Floor	Asbestos	VFT - 9x9 white with green + mastic - black	20	60	sq ft	Good	No	Beneath carpet tiles
1		119	Floor	Asbestos	VFT - 9x9 teal with white + mastic - black	23	96	sq ft	Good	No	
1		123	Floor	Asbestos	VFT - beige with brown + mastic - black	24	300	sq ft	Good	No	
1		123	Floor	Asbestos	VFT - 9x9 grey with black + mastic - black	25	300	sq ft	Good	No	
1	124	124	Floor	Asbestos	VFT-9x9 grey with black + mastic - black	25	132	sq ft	Good	No	
1		123	Floor	Asbestos	VFT - oatmeal pattern + mastic - black	26	300	sq ft	Good	No	
2	215, 215A, 215B	215	Floor	Asbestos	VFT - oatmeal pattern + mastic - black	26	12	sq ft	Good	No	
1	124	124	Floor	Asbestos	VFT- oatmeal pattern + mastic - black	26	132	sq ft	Good	No	
2		203	Floor	Asbestos	VFT - 9x9 brown with multicolored streaks + mastic - black	30	400	sq ft	Good	No	Beneath carpet tiles. Limited access

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
2	208	208	Floor	Asbestos	VFT - 9x9 brown with multicolored streaks + mastic - black	30	64	sq ft	Good	No	
2	210, 210A, 210B, 210C	210	Floor	Asbestos	VFT - 9x9 brown with multicolored streaks + mastic - black	30	450	sq ft	Good	No	
2	215D,215C,216	216	Floor	Asbestos	VFT- 9x9 white with brown streaks + mastic - black	31	121	sq ft	Good	No	Beneath carpet tiles
2	219, 219A, 219B, 219C	219	Floor	Asbestos	VFT - 9x9 white with brown streaks + mastic - black	31	500	sq ft	Good	No	Beneath carpet tiles
2	Breaker room	220	Floor	Asbestos	VFT - white with brown streaks + mastic - black	31	72	sq ft	Fair	No	Tiles missing
1		102	Floor	Asbestos	VFT - 9x9 white with brown streaks + mastic - black	31	275	sq ft	Good	No	
2	203B	203	Floor	Asbestos	VFT- 9x9 white with brown streaks + mastic - black	31	176	sq ft	Good	No	Beneath carpet tiles
2	207, 207B	207	Floor	Asbestos	VFT- 9x9 white with brown streaks + mastic - black	31	345	sq ft	Good	No	
2	215, 215A, 215B	215	Floor	Asbestos	VFT- 9x9 blue with white streaks + mastic - black	32	70	sq ft	Good	No	
2	215D, 215C, 216	216	Floor	Asbestos	VFT - 9x9 blue with white streaks + mastic - black	32	77	sq ft	Good	No	Beneath carpet tiles
2		223	Floor	Asbestos	VFT - 9x9 blue with white + mastic - black	32	276	sq ft	Good	No	Beneath carpet tiles
2	204B	204	Floor	Asbestos	VFT- 9x9 blue with with streaks + mastic - black	32	156	sq ft	Good	No	
2	213, 213A, 213B, 213C	213	Floor	Asbestos	VFT - 9x9 blue with white + mastic - black	32	260	sq ft	Good	No	
2	204B	204	Floor	Asbestos	VFT-black with white streaks + mastic - black	33	40	sq ft	Good	No	
1	C103	103	Floor	Asbestos	VFT-grey with black streaks + mastic - black	34	16	sq ft	Good	No	

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Floor	Room Name	Room #	Structure	Designated Substance	Material	Sample ID	Quantity	Units	Condition	Friability	Comments
1	113A	113	Floor	Asbestos	VFT - grey with black streaks + mastic - black	34	300	sq ft	Good	No	
2	204B	204	Floor	Asbestos	VFT - grey with black streaks + mastic - black	34	54	sq ft	Good	No	
2	213, 213A, 213B, 213C	213	Floor	Asbestos	VFT - grey with black streaks + mastic - black	34	260	sq ft	Good	No	
2	219, 219A, 219B, 219C	219	Floor	Asbestos	VFT- 9x9 red with white streaks + mastic - black	36	25	sq ft	Good	No	Beneath carpet tiles
1		128	Floor	Asbestos	VFT- 9x9 red with white streaks + mastic - black	36	450	sq ft	Good	No	
2	209, 209A	209	Floor	Asbestos	VFT- 9x9 red with white streaks + mastic - black	36	205	sq ft	Good	No	
2	C201		Floor	Asbestos	VFT- 9x9 red with white streaks + mastic - black	36	20	sq ft	Good	No	
2	209, 209A	209	Floor	Asbestos	VFT-orange/red + mastic - black	37	70	sq ft	Good	No	Some VFT seem more faded than others
2	209, 209A	209	Floor	Asbestos	VFT-dark multi red + mastic - black	38	18	sq ft	Good	No	
2	213, 213A, 213B, 213C	213	Floor	Asbestos	VFT - army green with white	39	170	sq ft	Good	No	
1		112	Floor	Asbestos	VFT - multigrey + mastic - black	42	16	sq ft	Good	No	
1		111	Floor	Asbestos	VFT - tan and brown + mastic -black	44	65	sq ft	Good	No	Likely installed at same time as other 12x12 tiles. Other tiles sampled are Samples 26, 42
1		138	Other	Asbestos	Transite board	N/A	50	sq ft	Good	No	Presumed ACM
2	209, 209A	209	Other	Asbestos	Sink undercoating - gold	N/A	2	units	Good	No	Presumed ACM

Note: Green cells indicate ACM VFT and black mastic/ Orange cells indicate non-ACM VFT but ACM containing black mastic

Appendix 'B'

Letter Report: Spray-Applied Beam Insulation Inspection – Former VMI Building – Ontario Veterinary College

Prepared by LEX Scientific Inc., June 2018 (LEX Project No. 01180066)

August 30, 2018
LEX Project No. 01180066-B

Mr. Peter Ibrajev
University of Guelph – Physical Resources Dept.
J.C. Hersey Building, 117 College Avenue East
Guelph, ON N1G 2W1

Re: Spray-Applied Beam Insulation Inspection
Former VMI Building – Ontario Veterinary College

Dear Mr. Ibrajev:

LEX Scientific Inc. (LEX) was retained by the University of Guelph – Physical Resources Dept. (the University) to conduct a visual confirmation inspection of Spray-Applied Beam Insulation (spray insulation) at the Ontario Veterinary College – Former VMI Building located at 50 College Ave. West, Guelph, ON. The inspection was requested to confirm the presence of asbestos containing fireproofing. The inspection was conducted by LEX Environmental Technologist Jarrett Deneau, B.Sc., on August 23, 2018.

The spray fireproofing insulation was identified to have been historically present from an internal review of University of Guelph documents. In addition to this, the following signage was present adjacent to the ceiling tiles in two locations where the fireproofing was historically identified. The signage stated: "*Asbestos Containing Materials above Ceiling Tiles. Please use Type 2 Procedures when entering this space. For more information call ext 2030*." As such, prior to LEX conducting a visual confirmation inspection, Fibrecon Insulation (Fibrecon) erected small enclosures in the corridor areas selected at the locations where fireproofing was potentially present. See **Attachment #1** for markup's of floor plans showing the locations of the enclosures.

LEX did not observe any materials of note in the ceiling space of inspection enclosure #1 located in corridor C102.

During the inspection, LEX observed the spray insulation along multiple beams in the ceiling space of corridor C201, outside room 217 in inspection enclosure #2. However, due to the extremely limited view above the ceiling tiles, the spray insulation was only be observable from the limited area exposed along the north side of the wall within the enclosure.

LEX observed what appeared to be spackling or dust along the decking beam located in inspection enclosure #3 in corridor C202. It does not appear to be spray insulation but could potentially be residue if fireproofing had been historically present and abated at some point.

Pictures of interest pertaining to the inspection can be viewed in **Attachment #2: Photolog of Notable Pictures**.

Between May 14 to 18, 2018, LEX conducted a Designated Substances Survey (DSS) of the building. During the survey, no spray insulation was observed by LEX staff. As part of the survey, LEX opened up multiple ceiling tiles to inspect the ceiling space along the corridors throughout the building. It was likely that the spray insulation was not observed due to extremely limited visibility in the ceiling space of the corridors. This was compounded by the limited amount of ceiling tiles that LEX staff thought could be removed and replaced without causing substantial damage to the tiles.

On behalf of LEX, we would like to thank you for the opportunity to serve you. If you have any questions regarding this report or any health and safety issue, please call us at (519).824.7082.

Yours truly,

LEX Scientific Inc.

Jarrett Deneau, B.Sc.
Environmental Technologist

Eric Hoffbauer, P. Eng.
Project Manager – Consulting Services

Attachment #1: Floor Plans Showing Enclosure Locations

Attachment #2: Photolog of Notable Pictures

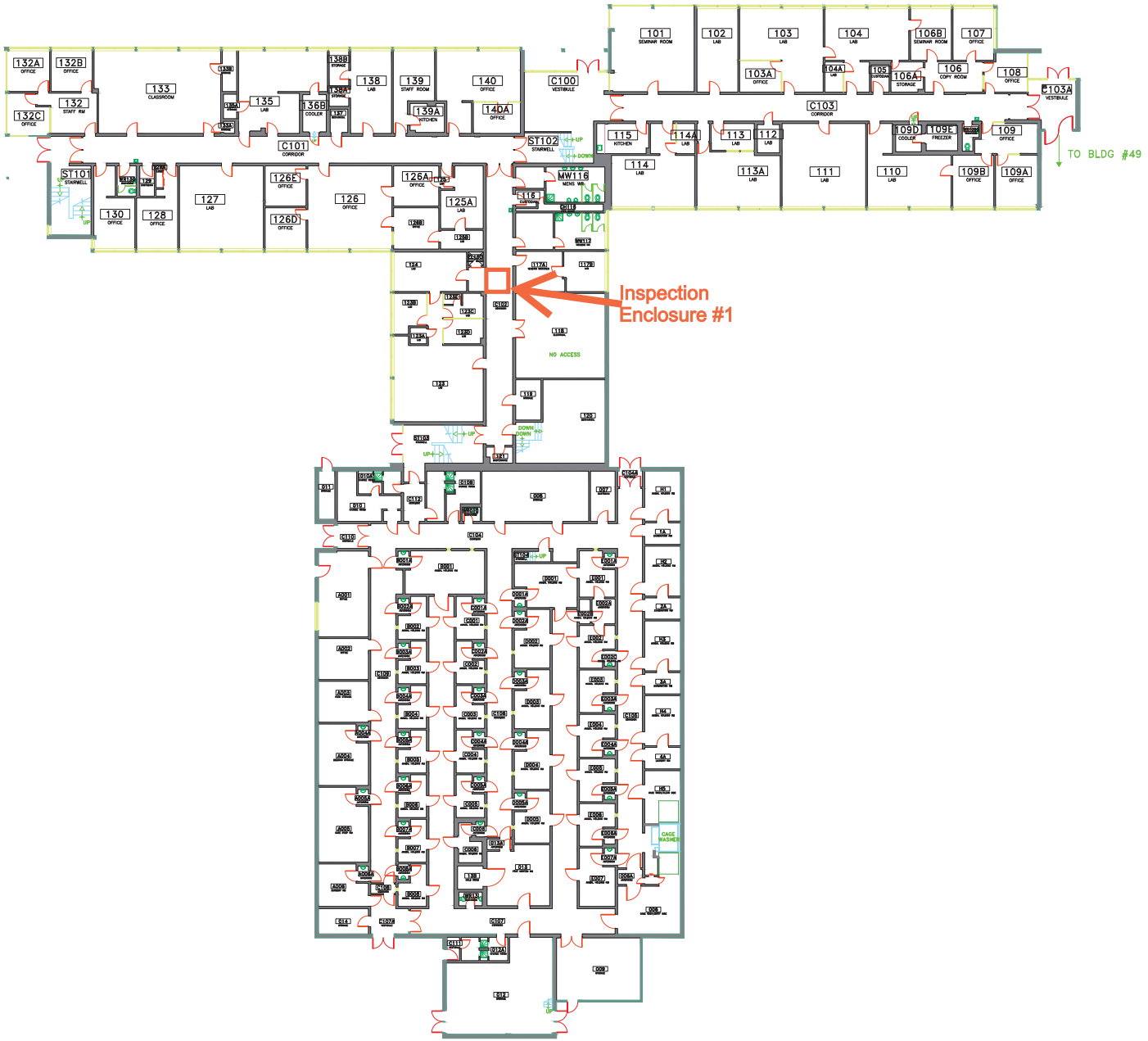
Disclaimer

This report is prepared exclusively for the purposes, project and site location outlined in the report. The report is based on information provided to, or collected and/or obtained by LEX as indicated in the report, and applies solely to site conditions existing at the time of sampling. LEX's report represents a reasonable analysis and interpretation of available information within an agreed scope of work, schedule and budget.

LEX's liability to the Client and all claimants not party to this agreement shall be limited to injury or loss caused by negligence of LEX and/ or sub-consultants for which it is responsible. The total amount of LEX's liability for said negligence shall be limited to the lesser of the fees paid for or actual damages incurred by the Client and the Client hereby waives all claims in excess of this amount howsoever arising including any claim for contribution and indemnity which the Client may have against LEX. The Client irrevocably and unconditionally agrees to defend, indemnify and hold LEX harmless from all claims and expenses associated therewith resulting from claims brought by other parties in excess of the aforesaid limit.

LEX prepared this report for the sole benefit of University of Guelph – Physical Resources Dept.; it reflects LEX's best judgment in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. LEX accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

Attachment 1



DO NOT SCALE DRAWINGS:

Contractors must check and verify all site conditions. Notify the Owner's Representative in writing before proceeding with the work if discrepancies are evident between the drawings and the site condition. No extras to the contract will be allowed if discrepancies were evident prior to start of work.

ASBESTOS:

Perform all work avoiding contact or disturbance of any asbestos materials. If asbestos or suspected asbestos containing materials are discovered during the work, all work must stop. At that point, the Contractor is to bring in an Asbestos Removal Contractor along with the Owner's Representative to review the extent of the work & provide a quotation to the University of Guelph's Construction Dept. for subsequent removal. Work shall resume after the Owner's Representative has approved such action.

Reference Documents

A = Detail number
B = Sheet number where detailed

NO.	ISSUED	BY	DATE
5			
4			
3			
2			
1			

Orientation

Project North

UNIVERSITY of GUELPH
Planning, Engineering & Construction
Physical Resources
Guelph, Ontario. N1G 2W1

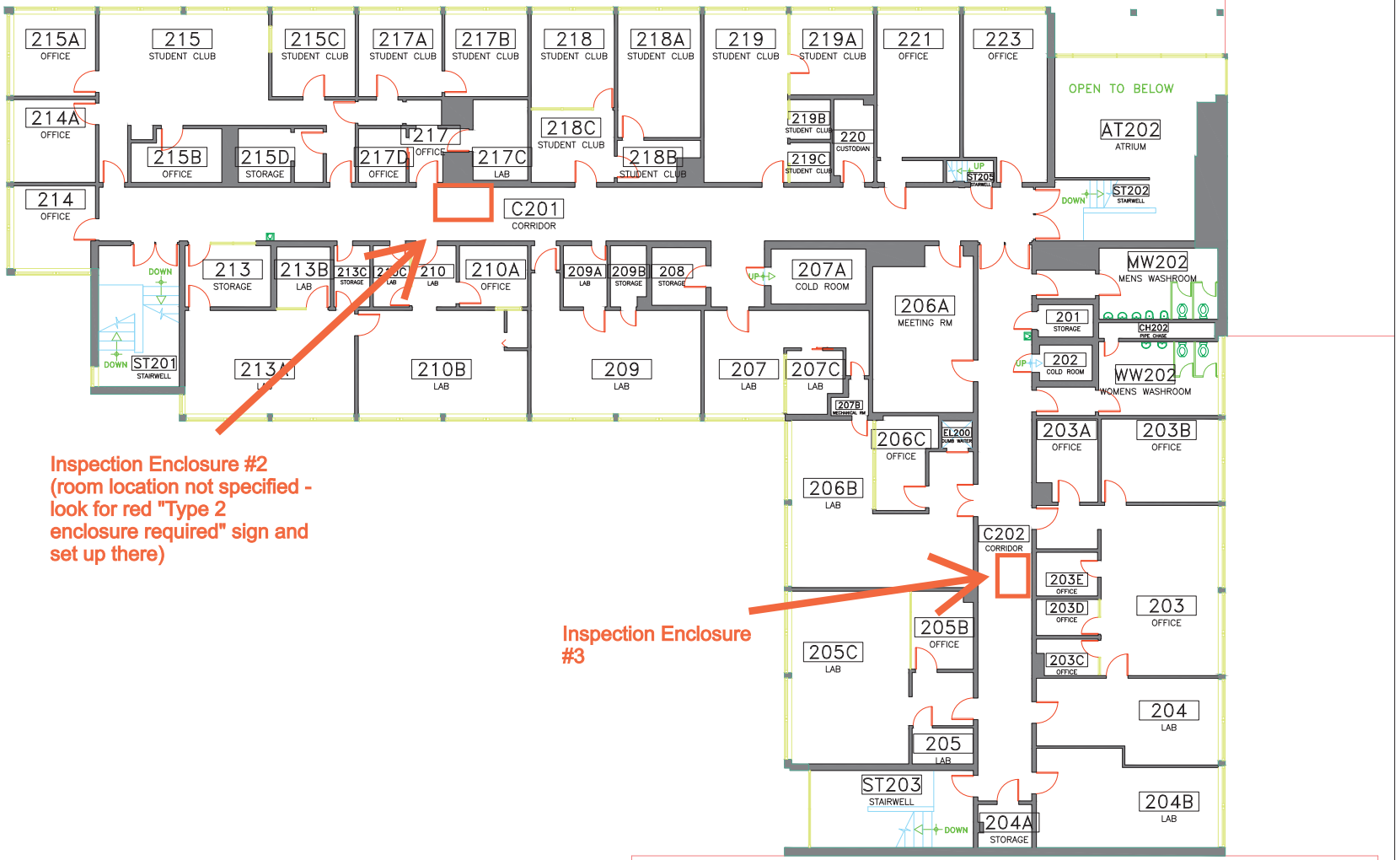
Project
BASE PLAN

Drawing Title
FIRST FLOOR

Project No.

Location
University of Guelph
FORMER VMI-Bldg.#046

Scale	Date
N.T.S.	MARCH, 2015
Drawn by: B.M.T.	Drawing No. B-1 of 1
Client's Approval	
Approved by	
Cad File No.	



Reference Documents

A = Detail number
B = Sheet number where detailed

NO.	ISSUED	BY	DATE
5			
4			
3			
2			
1			

Orientation

Project North

UNIVERSITY of GUELPH
Planning, Engineering & Construction
Physical Resources
Guelph, Ontario. N1G 2W1

Project
SPACE USE

Drawing Title
SECOND LEVEL

Project No.

Location
University of Guelph
FORMER VMI–Bldg#046

Scale	Date
N.T.S.	MARCH 2013
Drawn by: B.M.	Drawing No. B – 2 of 1
CEnt's Approval	
Approved by: J.V.	

Cad File No.

Attachment 2

Attachment #2: Photolog of Notable Pictures

Photo 1: Spray insulation on beam above ceiling tiles from within enclosure located in corridor C201.

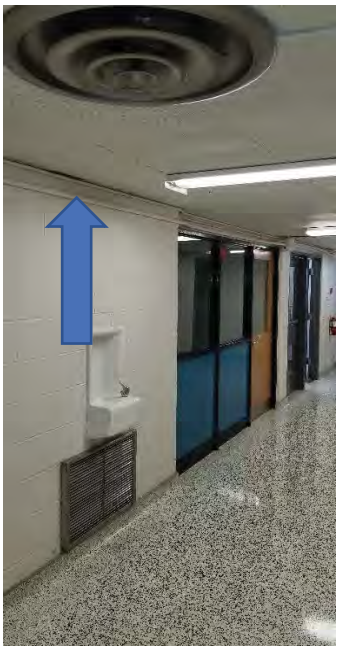


Photo 2: Approximate closest location where LEX inspected the ceiling space during the DSS. Located in corridor C201 outside room 213. Ceiling space easily accessible as hatch is equipped with a hinge. Fireproofing not visible from here.

Photo 3: No spray insulation visible on beam located in ceiling space in enclosure located in corridor C202. Specks visible on the beam.

Photo 4: Specks visible on beam above the ceiling of the vestibule C100. Similar to what was observed in corridor C202. Appeared to be dust or cement residue from application.

Appendix 'C'

Footing and Subgrade Inspection and Recommendations

Prepared by Chung & Vander Doelen Engineering Ltd., July 7, 2018

CHUNG & VANDER DOELEN
ENGINEERING LTD.

311 VICTORIA STREET NORTH
KITCHENER / ONTARIO / N2H 5E1
519-742-8979

SUBJECT:	**Footing and Subgrade Inspection and Recommendations**		
DATE:	July 7, 2018	**FILE NO.:**	M181172
TIME:	9:00 AM	**WEATHER:**	Interior
PROJECT:	Building 046 Renovations		
LOCATION:	University of Guelph	**CLIENT:**	Physical Resources, Design, Engineering &Construction University of Guelph
REPORTED TO:	Peter Ibrajev	**INSPECTED BY:**	Adam Mamon
AREA INSPECTED:	Proposed Elevator and High Density Storage		

As requested, a representative of CHUNG & VANDER DOELEN ENGINEERING LTD. (CVD) attended the site to inspect the existing subgrade conditions below the proposed areas.

Elevator

1. The existing building footing extends 1.05m below the existing finished floor elevation. The foundation comprises of 3.5 courses of masonry block on a 6-7" thick concrete footing.
2. The exposed subgrade material at the footing elevation consists of dense native Silty Sand and Gravel and is suitable to support a maximum bearing resistance of 150 kPa at SLS and 250 kPa at ULS. Subgrade suitability should be confirmed by the Geotechnical Engineer prior to pouring footings.
3. It is understood that the design footing elevation for the proposed elevator footing is 1500mm below the existing finished floor, or approximately 450mm below the existing underside of footing elevation.
4. Conventional spread footings are acceptable for use as the elevator footing. The subgrade materials are stable with no groundwater observed, therefore the excavation can be cut vertically against the existing footing for the elevator footing construction. The excavation should not be left open for an extended period of time.
5. The existing building footing should not be undermined during construction. CVD can assess the stability of the exposed existing footing soils during the excavation and construction.
6. No additional frost protection is required.
7. The existing subgrade materials are suitable for reuse as subgrade backfill.

High Density Storage

Existing Conditions:

1. An area measuring approximately 0.6m by 0.9m was cut into the existing concrete floor slab along the north wall of the proposed high density storage room.
2. The existing concrete slab is approximately 4.5" thick and does not contain any reinforcement. No voids were observed below the floor slab.
3. The composition of the existing slab base and subbase was generally found to consist of 6" of compact crushed clear stone overlying dense Silty Sand and Gravel with loose to compact fill of the same composition along the foundation wall.

CHUNG & VANDER DOELEN
ENGINEERING LTD.

311 VICTORIA STREET NORTH
KITCHENER / ONTARIO / N2H 5E1
519-742-8979

SUBJECT:	**Footing and Subgrade Inspection and Recommendations**		
DATE:	July 7, 2018	**FILE NO.:**	M181172
TIME:	9:00 AM	**WEATHER:**	Interior
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LOCATION:	University of Guelph	**CLIENT:**	Physical Resources, Design, Engineering &Construction University of Guelph
REPORTED TO:	Peter Ibrajev	**INSPECTED BY:**	Adam Mamon
AREA INSPECTED:	Proposed Elevator and High Density Storage		

4. The existing underside of the foundation along north wall is 1.05m below the existing finished floor elevation with a 5" to 6" thick concrete footing and masonry block foundation wall.

Recommendations:

1. The imposed load on the concrete floor slab was provided by J.L. Richards and Associates Ltd. as 7.2 kPa for the desired type of storage racking used.
2. The existing floor slab, base and native subbase is considered suitable to support the specified load however it is recommended to consider the following conditions:

    A. Due to the loose to compact backfill along the north foundation wall encountered in the test pit, the racking storage system should be placed a minimum of 1.2m away from the wall to avoid differential settlement caused by the unsuitable foundation wall backfill material. This condition is also likely to exist against the east wall and the racking should also be kept away 1.2m.

    B. To optimize the amount of area suitable to support the specified racking storage load, CVD recommends removing the concrete slab below the proposed area. The loose subgrade material should be removed and re-compacted as engineered fill. The existing fill is suitable for reuse as the subbase and should be compacted to 98% SPMDD. The crushed clear stone base should be replaced to match the existing base and the concrete slab should have a minimum 28 day strength of 25 MPa.

Reviewed By:

Eric Y. Chung, M.Eng, P.Eng

Appendix 'D'

University of Guelph Standard Operating Procedures (SOP):

IU.324 – Procedures for Getting Supplies In and Out of the Facility

IU.326 – Donning and Doffing of Personal Protective Equipment (PPE)

IU.329 – Personal Items in the Containment Zone

Standard Operating Procedures	
UNIVERSITY of GUELPH **Isolation Unit**	Title: **Procedures for Getting Supplies In and Out of the Facility**
	SOP Number: **IU.324** Approval Date: February 2017 Revision Date:

PURPOSE: To provide instructions for getting supplies and equipment in and out of the Isolation facility to implement bio- security and containment

POLICY: To meet or exceed the standards as set out in the CCAC Guide to the Care and Use of Experimental Animals and CCAC guidelines and the Canadian Biosafety Standards and Guidelines

PROCEDURES:

***Cardboard boxes or Styrofoam containers are not to be used as storage. Cardboard is not to be brought into the facility. Only when samples are to be put on ice, can Styrofoam be brought in.**

A. Movement of single use cardboard boxes for oocyst collection from outside storage room

- researcher must make sure that boxes are free from any debris that may have accumulated on the boxes while in the outside storage room
- boxes must be doubled bagged and bags must be securely tied
- researcher must enter the building using main entrance going through the disinfectant mats
- it is recommended that personnel change into facility specific scrubs
- proceed directly to the designated room, put on the boots and disposable gown, mask, gloves and bonnet and bring the boxes right into the room
- when all of the doors are closed in the room, they may remove the boxes from the bags and leave the bags in the room
- an Isolation staff member will remove and dispose of the bags through the dirty corridor

B. Bringing in small to medium supplies to be used in an animal room

- any item that will be required within the animal containment area, must be double bagged

- bags are located in the main entrance foyer
- if more bags, or bigger bags are required, get assistance from a staff member before entering the facility with supplies
- remember that supplies **cannot** be brought from one room to another
- if you are dealing with multiple rooms, multiple packages should be made up and have one designated for each room
- do not share sharps containers between rooms, bring one small container for each room
- when you have your supplies double bagged, make your way to the assigned animal room
- open the door to the ante room and before donning personal protective equipment(PPE)remove the first bag and place it on the designated clean shelf in the ante room
- step into the ante room, stepping into the boots and set bagged supplies on a stable surface
- put on PPE (if PPE is not in the ante-room, it will be located in a rolling storage bin in the hall way and will need to be gathered before entering the ante-room)close hallway door , enter housing room and perform what procedures are needed
- exit room and enter ante room, remove dirty items from the dirty bag and place them in the clean bag on the clean shelf. Dispose of dirty bag in garbage.
- remove one pair of gloves and seal clean bag
- remove PPE and exit ante room into the clean hallway
- upon request research teams can be provided with disinfectant that is effective against the agent in use

C. Bringing in large or bulky supplies to be used in an animal room

- any item that will be required within the animal containment area, must be double bagged
- bags are located in the main entrance foyer
- if more bags, or bigger bags are required, get assistance from a staff member before entering the facility with supplies
- remember that supplies **cannot** be brought from one room to another
- if you are dealing with multiple rooms, multiple containers should be made up and have one designated for each room
- when you have your supplies double bagged, make your way to the assigned animal room
- step into the ante room, stepping into the boots and set bagged supplies on a stable surface
- put on PPE (if PPE is not in the ante-room, it will be located in a rolling

storage bin in the hall way and will need to be gathered before entering the ante-room) , close hallway door, enter housing room, remove both bags and perform what procedures are needed
- leave large and bulky items in the room and an Isolation staff member will dispose of the bags and ensure large and bulky items are washed and returned to the clean corridor.
- remove PPE and exit ante room into the clean hallway

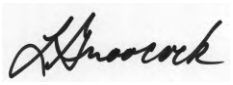
D. Bringing in Supplies to be used in the post mortem (PM) room

- if tissue collection or necropsies are to be done several times throughout the stay, a labelled plastic container with supplies may be left in the PM. This will help prevent the likelihood of cross contamination since supplies will not be going back and forth
- place equipment inside a durable, puncture resistant container and place in double garbage bags supplied at the entry way to Isolation Facility
- transport this equipment through clean halls in closed bags that are placed on lab carts to the PM room
- open the door to the ante room and before placing on personal protective equipment(PPE), remove the first bag and place it on the designated clean side of the shelf in the ante room
- step into the ante room, stepping into the boots and set bagged supplies on the dirty side of the shelf in the ante room
- put on PPE, close hallway door , enter PM room and perform what procedures are needed
- after you are done in the PM room, wipe down equipment with disinfect and place supplies in remaining bag
- exit PM room and enter ante room, remove dirty items from the dirty bag and place them in the clean bag on the clean side of the shelf. Dispose of dirty bag in garbage.
- remove one pair of gloves and seal clean bag
- remove PPE and exit ante room into the clean hallway
- if large quantities need to be removed from the building, arrangements can be made with the Isolation staff to pass it out the back door to a waiting member of the research team

E. Removing a cage of mice from the facility

- bring two bags from the main entrance
- open the door to the ante room and before placing on personal protective equipment(PPE), place one bag on the designated clean shelf in the ante room
- step into the ante room, stepping into the boots and set second bag on a stable surface
- put on PPE, close hallway door, enter housing room and locate the cage for removal
- within the animal containment area, place the cage in one bag and tie a knot in the bag providing an air bubble
- exit room and enter ante room and place the bagged cage into the clean bag on the clean shelf.
- remove one pair of gloves and seal the second clean bag
- remove PPE and exit ante room into the clean hallway
- alternatively, if exiting via the dirty corridor please coordinate with the lead hand or RAT x54428
- the transport container must protect animals from cold, heat, noise and wind; maintain bio-containment; and prevent animal escape. To that end, a cooler that may be disinfected between uses is recommended for transportation out of the facility.

Signatures

Author	Author	Author	Facility Manager	Facility Veterinarian
Name (please print): Linda Groocock	Name (please print): Vicky Carson	Name (please print): Tony Cengija	Name (please print): Mary Fowler	Name (please print):
Signature: 	Signature: 	Signature: 	Signature: 	Signature:

Standard Operating Procedures	
UNIVERSITY of GUELPH **Isolation Unit**	Title: **Donning and Doffing of Personal Protective Equipment (PPE)**
	SOP Number: **IU.326** Approval Date: February 2017 Revision Date:

PURPOSE: To outline the step-by-step process of donning and doffing of PPE

POLICY: To meet or exceed the Canadian Biosafety Standards and Guidelines

NOTE:

Donning and doffing of PPE is the process in which a person will put on and remove all PPE to decrease the possibility of exposing themselves to a contaminant.

When working with zoonotic pathogens and/or an airborne pathogen, precautions indicate that an N95 respirator must be worn. With regards to exposure to lab allergens or unknown health status of farm animals an N95 respirator is recommended.

Risk assessments for appropriate PPE are conducted both departmentally and through the Biosafety Committee.

PROCEDURES:

A – PPE for Entering the Animal Containment Rooms

DONNING

- PPE for all rooms (other than long-term mouse rooms) is located in rolling storage bins in the hallway
- Disposable gown must be worn in most animal rooms. Make sure both sets of strings are tied (one set behind neck and the other around the waist).
- For rooms with cattle or swine, coveralls must be worn instead of disposable gowns.
- Put on surgical mask (ear loop straps are placed around ears), N95 mask or respirator (fit test required)
- Put on a bonnet, making sure all hair is tucked inside.
- Put on the first pair of gloves, then a second pair of gloves is pulled over the cuff of the gown or coveralls
- Remove shoes in the clean corridor, step on sill and step into room-specific boots, without touching them

- Unsoiled coveralls can be reused during the course of the day to re-enter the animal rooms. To use coveralls hanging in the anteroom, remove shoes in hallway and balance on the anteroom sill. Place one leg into leg of coveralls and set foot into boot, tucking coveralls in, then repeat this step for the other leg.
- Eye protection (if warranted through a risk assessment) is stored in a container with a lid within the anteroom. Put on eye protection as you enter the anteroom.
- Enter and service room

DOFFING

- When exiting room, step boots into the footbath in the ante room
- Remove and dispose of outside/dirty layer of gloves
- Remove mask with gloved hands (inside/clean gloves), along with the bonnet and eye protection
- Eye protection is wiped with an alcohol wipe and placed back into the container with a lid
- Remove disposable gown and throw in garbage
- If wearing coveralls, open the door to the hallway with gloved hands. Unbutton and unzip the coveralls. Remove boots as you step on the sill, and remove coveralls one leg at a time while balancing on the sill. Hang coveralls on the hook.
- Remove inner pair of gloves. Discard gloves in garbage
- Wash hands, refer to SOP IU.325 " Hand Hygiene"
- Exit ante room while gently removing boots, leaving them upright in the anteroom

B – Use of the PM room

DONNING

- If there is a risk of contamination through the disposable gown or coveralls, please wear facility specific scrubs under prescribed PPE (gown or coverall)
- Put on appropriate PPE as outlined in Section A, PPE is located in a rolling storage in located outside of the PM Room door
- Remove shoes in clean hall, and step into the boots dedicated for the PM room

DOFFING

- Remove PPE following the procedure outlined in "A" and dispose in designated waste
- If coveralls were worn, they are to be placed in the "Dirty laundry" bin
- Exit PM room via anteroom, slip off designated boots in the anteroom one at a time returning to your shoes in the clean hall
- Wash hands at the hands-free sink, refer to SOP IU.325 " Hand Hygiene".
- In the change room, remove facility specific scrubs. A shower is available and highly encouraged after work in the post mortem room. Change into street clothes and exit the facility

Signatures

Author	Author	Author	Facility Manager	Facility Veterinarian
Name (please print): Linda Groocock	Name (please print): Vicky Carson	Name (please print): Tony Cengija	Name (please print): Mary Fowler	Name (please print):
Signature:	Signature:	Signature:	Signature:	Signature:

Standard Operating Procedures	
UNIVERSITY of GUELPH **Isolation Facility**	Title: Personal Items in the Containment Zone
	SOP Number: IU.329 Approval Date: February 2017 Revision Date:

PURPOSE: Personal items should not be brought into the animal containment zone unless it is critical to the experiment or animal monitoring. This SOP will outline a step by step procedure to prevent personal items from becoming contaminated while working in the containment zone.

POLICY: To meet the Canadian Biosafety Standards and Guidelines

PROCEDURES:

- Before entering the containment zone, remove all personal items (e.g. cell phones, music devices, cameras etc) and leave them in the locker room. A combination lock may be placed on the locker for the duration of time you are working in the unit
- If you are required to bring a device into the containment zone, the device must be placed in a resalable plastic bag prior to entry. These bags are available in the front entrance of the Isolation unit or from any of the full time technicians in the unit
- Most cell phones and cameras can be used when placed in a zip lock bags, as this level of film does not interfere with touchscreens, but testing the device before going into the containment zone is recommended
- When preparing to exit the containment zone, the resealable bag with the device still contained within it must be disinfected in the anteroom. The technicians will supply disinfectant wipes when they supply the bags. Apply disinfectant to the outer surfaces before doffing your PPE, (refer to SOP IU.326 – "Donning and Doffing of PPE")
- Immediately after exiting the containment zone anteroom remove the reseable bag and dispose it in the garbage in the anteroom. Wash hands thoroughly.

Signatures

Author	Author	Author	Facility Manager	Facility Veterinarian
Name (please print): Linda Groocock	Name (please print): Vicky Carson	Name (please print): Tony Cengija	Name (please print): Mary Fowler	Name (please print):
Signature: 	Signature: 	Signature: 	Signature: 	Signature:

Appendix 'E'

EACO Mould Abatement Guidelines Edition 3 (2015)

EACO Mould Abatement Guidelines
Edition 3 (2015)

Foreword

This guideline has been prepared to assist building owners, constructors, contractors, subcontractors and workers who have duties under the Occupational Health and Safety Act and its Regulations to safely perform work activities involving Mould (Microbial) Abatement and remediation. The guideline is intended to promote safe work practices, the use of personal protective equipment, worker awareness and training and is based in a thorough review of the available guidance materials available to December 2014 and professional experience of the abatement industry in Ontario.

We believe that this guideline will not only help employers fulfill their responsibilities and due diligence under the Occupational Health and Safety Act but will also assist them to better address the challenges involved with proper assessment and remediation of Mould (Microbial) contamination in buildings.

Disclaimer

EACO disclaims any liability or risk resulting from the use of the work practices and recommendations discussed in the guideline. It is the user's responsibility to ensure that work practices and recommendations discussed in the guideline apply to specific workplaces and projects and to ensure compliance with all other applicable federal, provincial and local acts, codes and regulations.

EACO Mould Abatement Guidelines
Edition 3 (2015)

Table of Contents

SECTION A: GENERAL POINTS AND LIMITATIONS

1. Three levels of work practice are given for removal of Small, Medium and Large-scale Mould growth, depending on the extent of material supporting Mould growth present. The thresholds between Small and Medium project areas (10 ft^2) and between Medium and Large project areas (100 ft^2) are a guideline only and are subject to professional judgment. EACO recommends that the enumeration of Mould growth be based on an approximation of the extent of visible growth (total affected area of building material), including the estimated extent of any hidden Mould.

2. These procedures do not address the identification or control of the cause(s) of the Mould growth being abated by these procedures. This would include such factors as past flooding, moisture intrusion and elevated levels of relative humidity. The project authority is cautioned to ensure that the underlying cause(s) of the Mould growth is investigated and remedied prior to completing the Abatement process to reduce the potential for Mould re-growth.

3. These procedures do not address the potential for fungal infections that may be acquired by Susceptible Occupants in hospitals or other health care settings if Mouldy materials are disturbed without appropriate precautions. Refer to "Construction-related Nosocomial Infections in Patients in Health Care Facilities – Decreasing the Risk of Aspergillus, Legionella and Other Infections", July 2001, Canada Communicable Disease Report, Health Canada and CSA Standard Z317.13-12, Infection Control During Construction or Renovation of Health Care Facilities.

4. These procedures do not address the potential presence of Designated Substances (asbestos, lead, etc.) or other hazardous materials in a mould remediation work area. The project authority is cautioned that designated substances are regulated in Ontario under the Occupational Health & Safety Act. In addition, Ontario Regulation 278/05, *Regulation Respecting Asbestos on Construction Projects and in Buildings and Repair Operations* (O. Reg. 278/05) outlines specific procedures for the handling and disturbance of asbestos-containing materials (ACM). Typical ACMs that may be disturbed as part of a mould remediation project include drywall joint filling compound, ceiling tiles, pipe and duct insulation and vinyl flooring.

5. These procedures are not directly intended to address Biohazards, other than Mould, potentially present in a project area as a result of contamination with sewage waste, river floods or other water with high levels of Microbial contamination. Appendix D does provide additional procedures for unsanitary remediation. The reader is referred to the guidance of the Institute of Inspection, Cleaning and Restoration Certification S500 Standard, "Standard and Reference Guide for Professional Water Damage Restoration." Additional precautions might apply.

6. These guidelines are not meant to respond to the development of minor areas of superficial mould growth in households due to water absorption or condensation on the occupied side of finishes, often referred to as lifestyle mould growth. Examples include spotty mould growth on grout in bathrooms or on cold window frames under winter conditions. Such areas of minor surface mould growth are generally limited in area and can usually be addressed with improved ventilation and/or moisture control, and standard house cleaning methods. However, if there are large areas of surface condensation or indications of sub-surface moisture sources, the area should be inspected for the possibility of hidden water damage or mould growth.

SECTION B: GENERAL PRECAUTIONS APPLICABLE TO ALL LEVELS OF MOULD ABATEMENT WORK

1. Protection of Occupants

1.1 The project authority should consider whether occupants should be removed from areas adjacent to the work area. The removal of occupants from spaces adjacent to the work area is not necessary in all cases but should be considered in the presence of Susceptible Occupants including but not limited to infants less than 12 months old, persons having undergone recent surgery, the elderly, immune suppressed people, or people with chronic inflammatory lung diseases.

2. Worker Training and Medical Pre-screening

2.1 Mould abatement workers shall be trained in the hazards of Mould Abatement and in the procedures to be followed. Training at a minimum shall include classroom and site instruction. Minimum training topics shall include: hazards of mould abatement; use and limitations of personal protective equipment such as respirators and gloves; proper abatement practices including site isolation, removal techniques, proper clean-up and decontamination procedures. General health and safety training should also be provided to workers, as required by the Occupational Health & Safety Act and regulations for construction sites, and waste handling and disposal regulations.

2.2 Workers must be fit to work with potential Mould or microbial exposure. Workers with a history of significant allergic disease (asthma, hay fever, hives, etc.) or with a potential immuno-compromised status (persons with an immune system disease, taking immune system suppression medication, etc.) should consult with an experienced physician to determine whether Mould removal activities, and the associated potential for exposure to pathogenic materials, would present an unacceptable health risk.

2.3 Mould Abatement workers who may encounter a risk of infectious disease from unsanitary water sources (sewage, river floods, etc.) should consult with an experienced physician regarding vaccinations to reduce the risk of infectious disease through available immunizations, particularly Hepatitis A and B, tetanus and polio.

3. Respiratory Protection

3.1 The respiratory protection in these procedures has been established for protection against fungal particulate material, for which a Respirator with a NIOSH-approved particulate filter will be adequate. Another type of Respirator may be required if the Mould Abatement will employ a Disinfectant with a volatile hazardous ingredient (e.g., household chlorine bleach). Consult MSDS data for specific respiratory protection in relation to specific cleaning products.

3.2 Respirators shall be NIOSH approved.

3.3 Workers should complete Respirator pre-screening as detailed in CSA Standard Z94.4-11, Selection, Care and Use of Respirators (Appendix E Figure E1) and, if required, consult with an experienced physician to determine if a Respirator can be used without serious difficulty.

3.4 Respirator wearers shall be Fit-tested for each type of Respirator, prior to use, following CSA Standard Z94.4-11, Selection, Care and Use of Respirators.

3.5 Follow CSA Standard Z180.1-13 as amended, for testing of breathing air quality for supplied air respiratory protection required for dry ice abrasive blasting (see Appendix C).

3.6 Clean and maintain the Respirator and battery pack (where applicable) in accordance with manufacturer's recommendations.

3.7 No facial hair or spectacle side arms, which affect the seal of the Respirator to the skin, are allowed.

3.8 Dispose of filters daily due to the potential growth of Mould spores on damp filter media.

3.9 Due to the nature and working conditions of Mould Abatement, Filtering Facepiece Respirators shall not be utilized for Level 2 or Level 3 Abatement projects.

4. Personal Protection and Hygiene

4.1 Refer to the EACO Guideline Construction Worker Hygiene Practices 2014. Workers shall wear appropriate eye protection including safety glasses or goggles that provide protection from external debris (not required with full face negative pressure respirator), chemical splashes, impact or dusty environments, dust-impermeable gloves appropriate for the work underway and water-impermeable gloves for application of detergent and/or Disinfectant. Refer to the MSDS for the detergent and/or Disinfectant for glove selection.

4.2 Wash face and hands after work at the Abatement project each time after exiting the Abatement work area.

4.3 For all levels of work, eating, drinking or smoking is prohibited in the work area.

5. Cleaning

5.1 Pre-clean any items that will be retained, whether removed from the work area or covered and left in the work area. Use appropriate and effective cleaning methods.

5.2 After bulk removal, clean the surrounding areas with a HEPA vacuum. No other type of vacuum can be used. If a HEPA vacuum is not available, wet wiping may be adequate for Level 1 work.

5.3 Do not dry sweep or dry whisk. Use power tools only if fitted with effective HEPA-filtered dust collection.

5.4 Wipe all non-Porous surfaces within the removal area with a detergent solution. Rinse with clear water as required.

5.5 As an option, a Disinfectant solution can be used in place of, or in addition to a detergent. Apply the Disinfectant as specified by the manufacturer, maintaining the surfaces wet for the prescribed period. Generally, surfaces to be disinfected must be cleaned of all dust and loose organic material prior to application of the Disinfectant. A Disinfectant is required where the work area has been contaminated with a significant pathogenic hazard (i.e., sewage floods).

5.6 The project authority should consider the use of a Disinfectant in hospital or health care settings, or in other settings where the project authority believes occupants to be significantly immuno-compromised. Refer to the Health Canada and CSA guidelines for prevention of fungal infections in health care settings, given above.

5.7 Use only disinfectants with current Health Canada DIN registration. Apply the disinfectant according to the DIN label, observing requirements for mixing, storage time, worker safety, pre-cleaning, contact time, and any requirements for rinsing.

5.8 These cleaning requirements apply to all exposed surfaces within the work area. The project authority will determine if soft goods and Porous materials can be adequately cleaned or must be disposed of.

5.9 Clean all equipment used in the Abatement work area by HEPA vacuuming or wet wiping. Equipment that cannot be readily cleaned shall be HEPA vacuumed and sealed in 6 mil polyethylene bags before removal from the work area.

6. Post Abatement Cleanup

6.1 Remove Polyethylene sheeting used during abatement by carefully rolling towards the centre of the work area. Clean any visible dust and debris using a HEPA vacuum.

6.2 Clean all tools, supplies and equipment in the work area using a HEPA vacuum and by wet wiping. Equipment that cannot be readily cleaned (e.g. vacuum hose, wire brushes, etc.) shall be HEPA vacuumed and sealed in 6 mil polyethylene bags or suitable sealed containers before removal from the work area.

6.3 Seal the intake and exhaust of HEPA Filtered Exhaust Fans (negative air machines) and clean the cabinet by wet wiping, before removal from the work area.

6.4 Leave the work area and surrounding areas dry and visibly free of dust and debris.

7. Waste Disposal

7.1 Remove all waste as contaminated material, including but not limited to building debris, disposable coveralls, Respirator filters and/or cartridges, and plastic sheeting. All waste should be immediately double-bagged into two 6-mil polyethylene bags, each individually sealed. If the material cannot be bagged, wrap in 2 layers of 6 mil Polyethylene Sheeting and seal with tape.

7.2 Transport and dispose of the waste material in compliance with local, provincial and federal regulations, including the Ontario Environmental Protection Act and any other regulations, which may apply to the Mould or the substrate on which the Mould was located.

8. Post-Abatement Drying

8.1 By the completion of the mould abatement, ensure the cause of the mould growth has been identified and an action plan initiated to prevent further mould growth. This action would include mitigation of the original cause of the mould contamination. This would include such factors as past flooding, moisture intrusion or elevated levels of relative humidity. Also, at completion of mould abatement check that the remaining finishes (e.g., concrete, wood framing, sub-floors) have been adequately dried so that mould growth will not re-occur when new finishes are installed. The work area may require further drying efforts before re-construction can commence.

SECTION C: PRECAUTIONS FOR LEVELS 1, 2 AND 3 MOULD ABATEMENT

9. Level 1: Small Isolated Areas, Less than 10 ft^2 (1 m^2) of Building Materials or Clean-up of Less than 10 ft^2 (1 m^2) of Mould Growth in HVAC Systems in Non-occupied Areas.

9.1 This section gives instructions for performing Mould Abatement specifically for small-scale projects. This work practice is suitable for the abatement of under about 10 square feet of mould growth on building materials or finishes or the abatement of the same extent of mould growth within HVAC equipment in non-occupied areas such as mechanical rooms. Abatement of HVAC equipment in occupied locations shall be performed following a minimum of Level 2 procedures (contained mould abatement). Comply with all of the items of Section B, General Precautions (protection of occupants, worker training and medical pre-screening, respiratory protection, personal protection and hygiene, cleaning, and waste disposal) while performing this work.

9.2 The worker shall wear a half face piece air-purifying Respirator fitted with replaceable filters (N95 minimum) or a Filtering Facepiece Respirator (N95 minimum) plus appropriate gloves.

9.3 Workers shall wear full-body dust-impervious coveralls with attached hoods. Secure the coveralls tight at the ankles and wrists.

9.4 Turn off HVAC systems where possible and seal over any diffusers immediately adjacent to the work area.

9.5 Where possible, place a drop sheet below the Mouldy materials.

9.6 Dust Suppression methods should be used where possible, prior to disturbance of the Mouldy materials. Tape a section of plastic sheeting or duct tape over the Mouldy material, or if this is not feasible, lightly mist the Mouldy material with water.

9.7 Remove any Porous substrate materials (ceiling tiles, drywall, etc.) to a point beyond the immediate areas of visible contamination, for a minimum distance of 30 cm in all directions.

9.8 Clean the work area and dispose of the waste.

10. Level 2: Medium areas, 10-100 ft^2 (1-10 m^2) or less than 10 ft^2 (1 m^2) in HVAC Systems in Occupied Areas

10.1 This section gives instructions for performing Mould Abatement specifically for medium scale projects, or the abatement of less than 10 square feet of mould growth in HVAC equipment in occupied areas. Comply with all of the items of Section B, General Precautions (protection of occupants, worker training and medical pre-screening, Respiratory protection, personal protection and hygiene, cleaning, and waste disposal) while performing this work.

10.2 Consult with a qualified Health and Safety Professional prior to remediation work to provide Quality Assurance for the project and monitoring of compliance with these guidelines.

10.3 A competent supervisor must be present during all Contaminated Work.

10.4 The worker shall wear gloves appropriate for the work being done and full-body dust-impervious coveralls with attached hood. Secure the coveralls tight at the ankles and wrists.

10.5 The worker shall wear an elastomeric half face piece air-purifying Respirator fitted with 100 Series Filter cartridges.

10.6 Workers shall wear disposable boot covers or separate work boots that can be effectively HEPA vacuumed or wiped clean prior to removal from the work area.

10.7 Turn-off HVAC systems where possible and seal over any supply and return openings immediately adjacent to the work area. Objective of this engineering control is to maintain negative pressure and prevent the distribution of mould spores and dust from the work area.

10.8 The Abatement area must be secured and access restricted. Isolate the work area with an enclosure constructed of fibre-reinforced Polyethylene Sheeting or 6 mil Polyethylene Sheeting, taped and supported as required. Provide a temporary roof where an existing ceiling does not complete the temporary enclosure. The Project authority may require a single chamber decontamination/change room.

10.9 A Competent Supervisor or project authority must inspect the work area for defects in the enclosure, barriers and change room, at the beginning of every shift and at the end of every shift. Records of the inspections should be generated and maintained.

10.10 Install signs warning of the exposure hazard. Suggested wording: CAUTION, MOULD EXPOSURE, WEAR ASSIGNED PROTECTIVE EQUIPMENT, AUTHORIZED PERSONNEL ONLY.

10.11 Provide continuous Negative Pressure within the enclosure by drawing air from the work area and exhausting it out of the enclosure, either by use of a HEPA vacuum or a portable HEPA-filtered exhaust fan. Provide a minimum Negative Pressure of 5 Pascals (0.02 inches of water column) and at least 4 air changes per hour. Discharge the filtered air outside the building and away from persons wherever possible, and if this is not possible, consider on-site leak testing of the HEPA filtered equipment. Refer to the EACO DOP/PAO Testing Procedure Guideline 2013. Negative Pressure must be maintained until the completion of all Contaminated Work.

10.12 Remove any Porous substrate materials (ceiling tiles, drywall, etc.) to a point beyond the immediate areas of visible contamination, for a minimum distance of 30 cm in all directions.

10.13 Clean the work area and dispose of the waste.

10.14 Before exiting the work area, workers shall fully wipe or vacuum clean all footwear, coveralls and other personal protective equipment and remove and dispose of protective equipment not for re-use. Workers shall then complete personal cleaning as in Section B, General Precautions.

11. Level 3: Large Areas, More than 100 ft^2 (10 m^2), or more than 10 ft^2 (1 m^2) in HVAC Systems

11.1 The following work procedures describe the general set-up, conduct and safety measures for Level 3 Mould Abatement. Each project should be conducted following a site-specific work plan or specification developed by a Health and Safety Professional.

11.2 This section gives instructions for performing Mould Abatement specifically for large-scale projects. Comply with all of the items of Section B, General Precautions (protection of occupants, worker training and medical pre-screening, Respiratory protection, personal protection and hygiene, cleaning, and waste disposal) while performing this work.

Quality Assurance

11.3 Consult with a qualified Health and Safety Professional (qualified by knowledge, training and experience) with experience performing Microbial investigations and remediation, prior to remediation work, to develop a site specific work plan or specification and Quality Assurance services for the project and monitoring of compliance with these guidelines.

Quality assurance will include a combination of site inspections prior to abatement, during abatement, after abatement and clearance sampling including air sampling prior to dismantling of the abatement work area. Clearance sampling requirements to be defined by the appointed Health and Safety Professional. Refer to Section 11.22

Worker Protection

11.4 The worker shall wear a tight-fitting full face piece Powered Air Purifying Respirator with high efficiency particulate filters or a non-powered full face piece air purifying Respirator fitted with 100 Series Filters. Refer to Appendix C for respiratory protection for dry ice abrasive blasting.

11.5 The worker shall wear gloves appropriate for the work being done and full-body dust-impervious coveralls with attached hood. Secure the coveralls tight at the ankles and wrists.

11.6 Workers shall wear disposable boot covers or separate work boots that can be effectively HEPA vacuumed or wiped clean prior to removal from the work area.

11.7 A Competent Supervisor must be present during all Contaminated Work.

Site Isolation

11.8 Turn-off HVAC systems where possible and seal over any supply and return openings immediately adjacent to the work area.

11.9 Isolate the work area from adjacent spaces using temporary hoarding, tape and Polyethylene Sheeting, etc.

11.10 Install signs warning of the exposure hazard. Suggested wording: CAUTION, MOULD EXPOSURE, WEAR ASSIGNED PROTECTIVE EQUIPMENT, AUTHORIZED PERSONNEL ONLY.

11.11 Provide continuous Negative Pressure within the enclosure, through use of portable HEPA-Filtered Exhaust Fans. Provide a minimum Negative Pressure of 5 Pascals (0.02 inches of water column) and at least 4 air changes per hour. Note that higher levels of negative air pressure may be required to maintain site isolation. Discharge the filtered air outside the building and away from persons wherever possible, and if this is not possible, perform on-site leak testing of the HEPA filtered fan. Negative Pressure must be maintained until the completion of all Contaminated Work.

11.12 Negative Pressure within the enclosure shall be continuously measured and recorded with a portable monitor located at the entrance to the work area.

11.13 A Competent Supervisor and/or the Health and Safety Professional must inspect the work area for defects in the enclosure, barriers and change room, at the beginning of every shift, at the end of every shift where there is no shift beginning immediately following the shift that is ending, and at least once per day on days where there are no shifts. Records of the inspections should be generated and maintained.

Worker and Waste Decontamination Facilities

11.14 Provide a Worker Decontamination Facility, to include a clean change room and a dirty change room. Install flap doors at each opening into and within the decontamination facility. Provide a wash station consisting of at least a basin, fresh water, soap and toweling, in the clean change room. A shower for worker comfort may be provided, but is optional. Refer to Appendix A for a diagram of a typical Decontamination Facility.

11.15 When going into the Contaminated Work area the worker will don clean coveralls and a Respirator in the clean change room.

11.16 Prior to exiting the Contaminated Work Area, the worker will use a HEPA vacuum in the work area to remove gross contamination from coveralls and boot covers (or separate dirty work boots).

11.17 The worker will then enter the dirty change room where the dirty coveralls and boot covers are removed (to be used only once). Work boots used without boot covers will also be removed and stored in the dirty change room.

11.18 The worker then proceeds to the clean change room to complete clean up. The wash station is to be used by each worker on leaving the work area to clean face and hands.

11.19 A separate Waste Decontamination Facility, consisting of a double bagging room and a waste transfer room should be provided where large volumes of waste will be removed. Seal the waste into bags (or Polyethylene Sheeting sealed with tape) in the Contaminated Work area, and wipe the exterior of the bags or other containers. Transfer the waste to the double bagging room and place a second bag around bagged waste. Seal the second bag. Transfer the double-bagged waste into the waste transfer room for removal by workers entering from the outside of the decontamination facilities.

Removal, Salvage and Cleaning

11.20 Remove any Porous substrate materials (ceiling tiles, drywall, etc.) to a point beyond the immediate areas of visible contamination, for a minimum distance of 30 cm in all directions.

11.21 Clean the work area and dispose of the waste. Clean tools and equipment such as vacuums, negative air units or any other items that were exposed during abatement.

Clearance Inspection and Monitoring

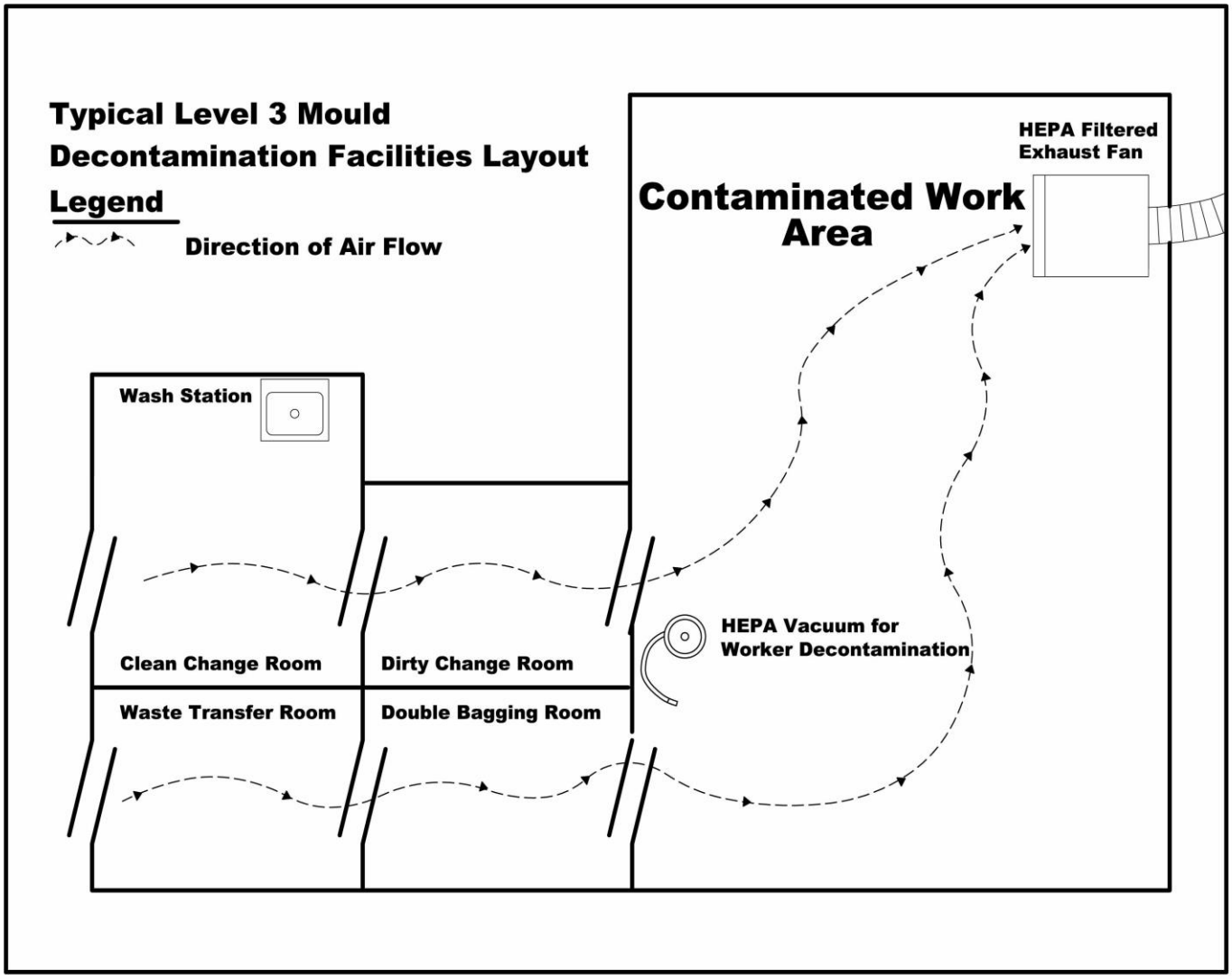
11.22 The Health and Safety Professional or representative should inspect the Level 3 work area for acceptable completion, by a combination of careful inspection and testing. A site will be considered acceptable and clean when a thorough inspection shows an acceptable state of cleanliness. In addition, Clearance air samples to be taken to indicate the work area is no longer impacted by the Mould contamination abatement process.

Generally, clearance air samples collected within the work area will be compared to samples taken in adjacent areas from where the work area make-up air is being drawn, another suitable location, or to outdoor air samples. An acceptable condition is indicated when:

1. Concentrations of airborne fungal particles in the work area are not significantly elevated when compared to concentrations in the reference area; and
2. The types of fungal particulate present in the work area do not significantly differ from those present in the reference area.

Surface samples should show minimal or no Mould growth remaining at completion. Interpretations of sample results are subject to the professional judgment of the Health and Safety professional with experience performing microbial investigation and remediation.

Appendix A: Typical Level 3 Mould Decontamination Facility Lay-Out



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Appendix B: Procedures for Clean-up of Bird and Bat Droppings

Workers removing accumulations of bird or bat droppings are at risk of exposure to airborne fungal spores (and other microbial hazards) likely to be released when this material is disturbed. Bird and bat droppings should be presumed to be contaminated with the fungi Histoplasma capsulatum, Cryptococcus neoformans, and other infectious hazards. The spores of some of these organisms can remain infectious for decades after their growth in the guano has ceased. Many of these microorganisms are known to cause respiratory infections in workers exposed during construction or maintenance disturbance.

NOTE: Although a disinfectant will be applied during this work, the treated excrement may still contain viable organisms and use of personal protective equipment should continue until the site is cleaned.

General Precautions during Abatement Work

1. Health and safety measures and procedures required during the abatement of bird or bat droppings shall be based on the findings of a project-specific risk assessment completed by a health and safety professional.
2. The project-specific risk assessment must consider conservation and/or habitat preservation.
3. The project-specific risk assessment should consider post abatement corrective measures that may be necessary to prevent the return of birds or bats (e.g. block openings into buildings or structure ledges, screen off ventilation intakes or other void openings, install netting/mesh or anti-roosting control systems, etc.).
4. Requirements of Section B (of this document) shall also apply, as applicable, for the clean-up of bird or bat droppings. Section B provides general guidance related to; protection of occupants, worker training and medical pre-screening, respiratory protection, personal protection and hygiene practices.

Personal Protection

All work will require the following personal protective equipment, as a minimum:

- Rubber boots (CSA approved for construction work).
- Either disposable gloves taped to coveralls and worn under work gloves, or heavy rubber or nitrile work gloves, taped to coveralls.
- Water-resistant disposable coveralls, complete with elasticized hood, taped to gloves and boots.
- Minimum of a full-face piece respirator fitted with appropriate cartridge filters. As a minimum, P100 filters are required for protection against airborne particles. Depending on the disinfectant used, the cartridge may require protection against vapours or gases. A powered air purifying respirator (PAPR) fitted with an appropriate cartridge filter may also be used, and will provide more comfort for the worker.

Appendix B: Procedures for Clean-up of Bird and Bat Droppings

Disinfectant

Use only disinfectants with current Health Canada drug identification number (DIN) registration. Apply the disinfectant according to the DIN label, observing requirements for mixing, storage time, worker safety, pre-cleaning, contact time, and any requirements for rinsing.

Hazard Sign

Install signs warning of exposure hazard during all abatement operations.

Site Isolation Considerations

The site isolation procedures implemented shall be based on the findings of a project-specific risk assessment. The following site isolation procedures, as a minimum, should be considered for all bird or bat dropping abatement operations.

1. Turn-off HVAC systems where possible and seal over any openings immediately adjacent to the work area.
2. Isolate the work area from adjacent spaces using temporary hoarding, tape and polyethylene sheeting, etc.
3. If the work area is enclosed, establish continuous negative pressure using portable HEPA-filtered exhaust fans. Provide a minimum negative pressure of 5 Pascals (0.02 inches of water column) and at least 4 air changes per hour. Refer to EACO document "*DOP / PAO Testing Guideline*, 2013", for guidance on negative air system testing and reporting requirements.
    a. Negative pressure within the enclosure shall be continuously measured and recorded with a portable monitor.
4. Provide a worker decontamination facility, to include a clean change room and a dirty change room. Install flap doors at each opening into and within the decontamination facility. Provide a wash station consisting of at least a basin, fresh water, soap and toweling, in the clean change room. Refer to Appendix A for a diagram of a typical decontamination facility.
    a. For large work areas, long term projects or areas with excessive amounts of bird or bat droppings, including a shower in the worker decontamination facility should be considered.
5. Additional considerations for outdoor operations:
    a. Install signs warning of exposure hazard, and ropes or barriers, around the perimeter of the work area, to the extent that is practicable, to prevent unauthorized personnel from entering the work area. All workers and personnel within the perimeter of the work zone must be adequately protected.
    b. Provide a worker decontamination facility as close to the work area as practical.
    c. Assess the prevailing wind patterns affecting the work area. Arrange the location of the worker decontamination facility, and sequencing of abatement operations, in a manner to minimize exposure to workers and surrounding areas.
    d. Complete an assessment to identify the location of fresh air intakes for building heating, ventilation and air conditioning (HVAC) systems. Fresh air intakes and/or HVAC

systems located within the perimeter of the work area shall be turned-off where possible and openings shall be sealed.

i. Clean HVAC system sheet metal that may have been contaminated.

ii. Replace HVAC air filters that may have been contaminated.

e. Isolate other routes of potential air transfer (into a building) located within the perimeter of the work area, such as windows, doors, void spaces, vents, etc.

f. If soil removal is required, soil pretreatment or decontamination may be required.

Work Practices

1. Dampen dry and dusty droppings with water to reduce the amount of airborne dust that may be created during abatement activities. Adding a surfactant to water (i.e. a wetting agent) may further reduce the amount of dust that becomes airborne.
    a. Wetting should be completed only by a low-pressure system or hose.
        i. Never wet bird or bat droppings using a high pressure power-washer system or using a high pressure garden hose setting (e.g. do not use direct or jet spray settings).
    b. Where bird or bat droppings are excessive, a prolonged wetting period and/or, repeated wetting during abatement work may be required.
        i. Never dry shovel or dry sweep bird or bat droppings.
    c. Avoid walking over areas with bird or bat droppings unnecessarily.
2. Perform an initial shoveling and HEPA vacuum removal of as much of the residue as possible.
3. Following a HEPA vacuuming, apply a disinfectant solution to all areas with visible residue. Apply with a garden sprayer set for droplet as opposed to mist spraying. Lightly brush to ensure uniform wetting and contact through to the underlying surface. Apply additional disinfectant as necessary to maintain the area wet for the contact time specified by the disinfectant manufacturer. Leave the material wet overnight where practical to do so.
4. Clean the area of residue with suitable tools and HEPA vacuuming. Lightly mist with water to reduce dust formation.
5. After surfaces have been cleaned of residue to the extent possible, apply a second application of the disinfectant and maintain wet contact time for the period recommended by the manufacturer. If the surface cannot be left with a residue, rinse and wipe with clear water.

Waste Collection and Disposal

Collect all waste into 6 mil disposal bags and immediately seal. Wipe the bag with the disinfectant solution and place into a second bag. Ensure proper notification and compliance with all applicable local, provincial and federal regulations including the Ontario Environmental Protection Act.

Appendix B: Procedures for Clean-up of Bird and Bat Droppings

Clearance Inspection

The project authority or representative should complete a detailed visual inspection of the work area to confirm that an acceptable level of cleanliness has been achieved.

NOTE: Currently there are no accredited analytical procedures able to measure the presence of viable organisms of *Histoplasma capsulatum*.

Post Abatement Corrective Measures

1. Review the findings and recommendations of the project-specific risk assessment. The project-specific risk assessment must consider conservation and/or habitat preservation.
2. The project-specific risk assessment should consider post abatement corrective measures that may be necessary to prevent the return of birds or bats (e.g. block openings into buildings or structure ledges, screen off ventilation intakes or other void openings, install netting/mesh or anti-roosting control systems, etc.).

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Appendix C: Additional Hazards with Abrasive Blasting in Mould Abatement

General guidance related to; protection of occupants, worker training and medical pre-screening respiratory protection, personal protection and hygiene procedures are found in Section of B of this document and shall apply, as applicable, for mould abatement using abrasive blasting,

Abrasive blasting techniques, using media such as soda, dry-ice or sand, are effective methods for the removal of mould growth from contaminated building materials. However, it must be recognized that additional hazards to workers and building occupants might exist when utilizing such methods. The primary hazards and additional precautions recommended for abrasive blasting of mould growth are summarized below:

- The aggressive disturbance of mould growth through blasting will result in much higher airborne mould concentrations than manual removal methods.

- Dry-ice blasting will release significant amounts of carbon dioxide (CO_2) into the work area which may result in an overexposure to carbon dioxide in enclosed work areas.

- The compressed air used to deliver the blasting media will reduce the negative pressure in the containment. Even smaller blasting equipment delivers 2000 cfm or more of additional air into the containment. This air supply will offset the negative pressure created by ventilation equipment.

- The pressure applied by the blasting equipment can transport or drive mould debris through various substrates, building elements, and assemblies (such as floor board seams, roof and wall sheathing seams, service penetrations, expansion joints) to an uncontained or occupied area where it may impact air quality or expose other workers, building occupants or the public.

Based on these hazards, the following precautions, in addition to the measures prescribed in Section B (of this document), should be followed when conducting abrasive blasting operations.

Containment

1. Level 3 precautions should be used for all blasting activities.

2. Ensure the substrate being blasted will not permit the penetration of blast media, dust or mould. If the substrate is likely to permit the transport of blast media, dust or mould then erect appropriate containment.

3. Provide adequate negative pressure ventilation during abrasive blasting. The ventilation must take into consideration the supply of air into the work area by the compressed air delivery of the abrasive media.

4. Continually monitor the workplace atmosphere for oxygen content and carbon dioxide when using dry-ice blasting methods.

Appendix C: Additional Hazards with Abrasive Blasting in Mould Abatement

Blast Media and Substrate Dust

5. Silica containing blast media should not be used wherever possible due to the high toxicity of fine silica dust. This is of particular importance in occupied buildings.

6. Ensure that adequate precautions are taken to control the hazards of the dust generated from the surfaces being impacted, which may include lead based and lead containing paints, silica containing substrate or asbestos containing materials.

Personal Protection

7. The minimum respiratory protection for all abrasive blasting activities shall be a full face piece air purifying respirator with P100 filters.

8. Wear supplied air respiratory protection for abrasive blasting with dry ice. Monitor carbon dioxide concentrations on an ongoing basis to determine the requirement for and adequacy of supplied air respiratory protection.

9. The addition of a worker decontamination shower should be considered, but is optional.

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Appendix D: Additional Procedures for Unsanitary Remediation

1. *Introduction and Scope*

- Buildings can be flooded with Unsanitary Water sources that contain micro-organisms that pose a risk of infection to occupants and abatement workers. Examples of Unsanitary Water include water originating from a sanitary sewer system, and flooding from over-land water or waterways. This appendix presents the precautions necessary for the cleaning of Unsanitary Water contamination.

- Further precautions will be required where there other hazards in addition to Unsanitary Water, such as mould growth, chemicals or asbestos.

- For further information on water damage restoration, refer to Standard and Reference Guide for Professional Water Damage Restoration, IICRC S500, Institute of Inspection Cleaning and Restoration Certification, 3rd Edition, 2006.

- Requirements of Section B (of this document) shall also apply, as applicable, for the remediation of unsanitary water. Section B provides general guidance related to protection of occupants, worker training and medical pre-screening, respiratory protection, personal protection and hygiene practices.

2. *Personal Protection*

All work with Unsanitary Water restoration requires the following personal protective equipment:

- CSA-approved construction-rated rubber boots.

- Water-resistant disposable coveralls, complete with elasticized hood, taped to gloves and boots.

- Rubber or nitrile work gloves, tape-sealed to the coveralls at the wrists and cuffs. Inspect before re-use. Wear puncture-resistant work gloves on top of the liquid-resistant gloves, where there is a risk of cuts or tears.

- Minimum of a half-face piece Respirator, fitted with a P100 cartridge filter. Odour protection can be provided with combination organic vapour and P100 cartridges.

- Chemical splash goggles, or a full-facepiece respirator fitted with P100 filters, or a Powered Air Purifying Respirator (PAPR) fitted with Type H filters.

3. *Isolation*

- Turn off HVAC systems where possible and seal over any openings immediately adjacent to the work area.

- Seal off the contaminated areas to prevent access by unauthorized persons. Consider polyethylene sheeting isolation to ceiling height if there a strong odour present or there will be significant demolition work. Negative pressure ventilation as specified for Level 2 Mould Abatement elsewhere in this guideline may be a useful additional precaution.

- Install signs warning of a Biological Hazard and restricting access to personnel with suitable protection.

4. Cleaning and Disinfection

- Generally, all porous materials impacted by Unsanitary Water cannot be de-contaminated and must be discarded. Dispose of all drywall, carpets, carpet tiles, soft furniture, etc.

- It might be possible to restore some porous contents impacted by Unsanitary Water (e.g., high-value carpets, clothing, documents) using specialized restoration services. Any decision to restore contaminated porous articles should be approved by the Competent Person. Post-disinfection testing with bacteria swab testing is recommended for these items.

- Package all waste contaminated with Unsanitary Water into sealed water-tight containers, typically a 6 mil polyethylene bag. Wipe the containers with the disinfectant solution. Alternately, wrap items with 6 mil polyethylene sheeting, seal with tape and wipe the exterior of the packaged waste with disinfectant.

- After removal of items and finishes to be discarded, clean all surfaces with a general-purpose cleanser prior to application of a disinfectant. All soiling must be removed before disinfection.

- Apply a Health Canada approved disinfectant to all surfaces impacted with Unsanitary Water. If the product is sold as a concentrate, mix according to the manufacturer's recommendations and use within the time given by the manufacturer. Observe the wet contact time specified in the Health Canada approval (typically 5 – 10 minutes), re-applying as necessary.

- If indicated by the manufacturer, rinse the disinfected surfaces with clean potable water.

- Ensure all mould-susceptible surfaces are dry within 24 hours. Ensure all other surfaces are adequately dry before the installation of mould-susceptible surfaces that could be impacted by excess trapped moisture.

5. Post-Disinfection Testing

- Collect surface samples to test for residual viable bacteria, by swabbing 100 square centimetre areas of typical disinfected surfaces or articles.

- Analyse the swab samples for *E. coli* and possibly other Unsanitary Water indicator bacteria.

- The standard of acceptance for *E. coli* on disinfected surfaces, is no detectable Colony Forming Units per 100 square centimetre area.

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Appendix E: Definitions

Term	Definition
Abatement	The process of returning a building or part thereof, from a condition of Biohazard, to background concentrations of biological agents and products, typical of buildings not affected by Mould contamination.
Biohazard	The presence of (a) biologically derived aerosols, gases, or vapours of a kind and concentration likely to cause disease or predispose persons to adverse health effects, or (b) indoor biological growth and remnants of growth that may become airborne and to which people may be exposed.
Canister or Cartridge	A container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.
Clearance Tests	Environmental tests (e.g., air samples, tape lifts, swabs) taken after Mould Abatement has been completed as a Quality Assurance measure.
Competent Person or Supervisor	A person who is qualified because of knowledge, training and experience to organize the performance of Mould Abatement, is familiar with Mould Abatement procedures, and has knowledge of the hazards of Mould and other dangers in the Abatement work area.
Contaminated Work	The portion of the Abatement project during which active disturbance, handling or cleanup of contaminated materials is occurring.
Cryptococcus neoformans	A pathogenic yeast growing in accumulated bird (usually pigeon) or bat Guano and posing a risk of cryptococcosis infections in heavily exposed or immuno-compromised individuals.
Disinfectant	Substance used to reduce the number of micro-organisms such as Moulds, bacteria or viruses to below the level necessary to cause infection. Some common Disinfectants, include sodium hypochlorite, quaternary ammonium compounds, and hydrogen peroxide.
DIN	Drug Identification Number. Registration number given by Health Canada for approval of disinfectants. Specifies the organisms against which the disinfectant is effective, and requirements for mixing, storage, application, and rinsing, if required.
Designated Substance	Hazardous materials (asbestos, lead, silica, mercury and others) designated by the Ontario Ministry of Labour for specific regulation under the Occupational Health and Safety Act. Property owners must notify contractors bidding on projects of the presence of Designated Substances. In addition to a regulation on asbestos, the Ontario Ministry of Labour has issued guidelines for the potential exposure from silica, lead, mercury and isocyanates on construction projects.
Dust Suppression	Measures taken to reduce the release of spores and other Mould-derived particulate matter during Mould Abatement.
Filtering Facepiece	Particulate-filtering Respirator where the facepiece is also the filter.
Fit-test	A qualitative or quantitative method to evaluate the fit of a specific make, model and size of Respirator on an individual.
Guano	Bird or bat dung, considered a risk for infection by Moulds or other micro-organisms.
HEPA Filtered Exhaust Fan	Portable exhaust fan in sealed cabinet equipped with HEPA filtration used to exhaust filtered air out of an enclosed Mould Abatement work area for the purpose of establishing and maintaining a Negative Pressure in the Mould Abatement work area with respect to surrounding areas, and also to provide general ventilation of the Abatement area.

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Appendix E: Definitions

Health and Safety Professional	An individual qualified by knowledge, skills, education, training and experience to perform assessments of Mould contamination, collect and interpret environmental tests, develop recommendations for Abatement work and provide inspection and Quality Assurance services.
HEPA	High Efficiency Particulate Air filter capable of trapping and retaining particles greater than or equal to 0.3 micrometers in diameter, at a minimum efficiency of 99.97%
Histoplasma capsulatum	A fungus frequently found growing in deposits of bird and bat Guano, and a risk for human infections during remediation work, renovation and demolition.
HVAC	Heating, ventilating and air conditioning (equipment).
Mould	Normally refers to fungi with filamentous growth form, often giving rise to "fuzzy", cottony, wooly or powdery textured colonies. Moulds produce spores that are poorly visible or not visible at all to the naked eye and that in many species are specialized to become airborne.
Microbial	Referring to any of Mould, bacteria, viruses or other micro-organisms.
MSDS	Material Safety Data Sheet, required by Workplace Hazardous Materials Information System (WHMIS) legislation, and giving information on hazardous materials, including properties, hazards, first-aid, emergency response, and personal protection.
N95	A Respirator particulate filter, 95% efficient at stopping a 0.3 micrometer aerosol, and not resistant to oil, a classification of particulate filters set by NIOSH.
Negative Pressure	A reduced pressure established within a Mould Abatement enclosure by extracting air directly from Abatement area, and discharging this air outside the work area. The discharged air must be HEPA filtered, the exhaust unit should be leak-checked and preferably the air is discharged outside the building.
NIOSH	National Institute for Occupational Safety and Health, part of the U.S. Centers for Disease Control and Prevention.
100 Series Filter	Any Respirator particulate filter, 99.97% efficient at stopping a 0.3 micrometer aerosol. A classification of particulate filters set by NIOSH.
Polyethylene Sheeting	Polyethylene Sheeting or rip-proof Polyethylene Sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required providing a continuous membrane to protect underlying surfaces from damage, and to prevent escape of airborne contamination through sheeting into occupied areas.
Porous	Permeable to Mould growth, allowing growth to extend significantly below the immediate surface.
Project Authority	Individual who has overall management responsibility for the project.
P100	A Respirator particulate filter, 99.97% efficient at stopping a 0.3 micrometer aerosol, and resistant to oil droplets, a classification of particulate filters set by NIOSH.
Quality Assurance	Measures of inspection, testing and documentation to promote confidence that the Abatement process will meet the desired goals.
Respirator	A device to protect the user from inhaling a hazardous atmosphere.
Susceptible Occupants	Persons with elevated risks of reacting to Mould exposure, usually due to allergic pre-disposition or compromised immune state. Examples include but are not limited to infants (less than 12 months old), persons recovering from recent surgery, or

Appendix E: Definitions

	people with immune suppression, asthma, severe allergies, sinusitis or other chronic inflammatory lung diseases.
Unsanitary Water	Water containing the known or presumed presence of harmful micro-organism such as *E. coli*, viruses or bacteria. Examples of Unsanitary Water include water originating from a sanitary sewer system, or flooding from over-land water or waterways.
Waste Decontamination Facility	A series of two rooms (Double-bagging and Transfer) constructed in such a way as to allow waste and equipment to enter and leave a Mould Abatement area without spreading contaminants beyond the Abatement area.
Worker Decontamination Facility	A series to two rooms (Clean and Dirty) constructed in such a way as to allow persons to enter and leave a Mould Abatement area without spreading the contaminants beyond the Abatement area.

NOTES

Appendix ‘F’

University of Guelph Commissioning - IT

Table of Contents

REVISION HISTORY

Version	Date	Author	Description of Revision
1.0	September 6, 2018	Audley Lloyd	Initial Release for Comment

1.0 Scope

1.0 This commissioning guide prescribes the inspection and test procedures. These procedures will help to verify and inspect that the Access Control, Video Surveillance, Intrusion and Duress System has been installed and meets all expectations. These installations will be in conformance with the projects scope of work, specifications, the project design, and the drawings.

1.1 The inspections and testing in this commissioning guide shall be documented for the commissioning and acceptance of all systems.

1.2 This guide contains commissioning forms for Building #046 Renovations, Guelph, Ontario.

1.3 The contractor shall verify successful operations of all components of the Surveillance Cameras system, Access Control system, Intrusion system and Duress alarm system.

2.0 Commissioning Standards

This guide prescribes specific examinations to confirm the compliance to the latest edition of applicable codes and standards including the following references:

2.1 ANSI/TIA/EIA - 758 Customer-owned Outside Plant Telecommunications Infrastructure Standard;

2.2 ANSI/TIA/EIA - 569 Commercial Building Standard for Telecommunications Pathways and Spaces;

2.3 ANSI/TIA/EIA -568 Commercial Building Telecommunications Standard;

2.4 ANSI/TIA/EIA – 607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications;

2.5 BICSI Telecommunications Distribution Design Manual; per the systems manufacturer's specifications, installation and warranty requirements.

2.6 National Electrical Code. National Electrical Safety Code and other related NFPA Codes and Standards.

2.7 Manufacturer's instructions.

3.0 Commissioning Guide – Contacts Required

a. Project Lead Representative:

b. Contractor Representative:
c. Client Representative:

4.0 Commissioning Guide – References Required

a. Project Scope
b. Tender Drawings
c. Tender Specification
d. Shop Drawings as submitted to
e. Equipment/Software Installation Manuals
f. Equipment/Software Operations Manuals
g. IP Device Tracking Log
h. Video Surveillance Commissioning
i. Access Control Commissioning
j. Intrusion Detection Commissioning
k. Duress System Commissioning
l. Video Surveillance System Verification Checklist (Provided)
m. Access Control System Verification Checklist (Provided)
n. Intrusion System Verification Checklist (Provided)
o. Duress System Verification (Provided)

4.1 Commissioning Guide – Checklist Completion

The Checklists will be distributed in electronic form, and the final version must be filled in electronically to ensure complete legibility. Once fully completed and all parties are satisfied, please forward a copy to all parties. Please print two (2) copies of the completed form to be signed off by all parties. One of the printed and signed copies is to be retained by the lead contractor, and the second will go the time client at system turnover.

5.0 Physical Security System Component Abbreviations

Device	Description
NVR	Network Video Recorder

REX	Request to Exit Sensor
CM	IP Camera
ES	Electric Strike
DC	Door Contact
ESSC	Electronic Safety and Security Cabinet
PB	Handicap Push Button
ED	Electronic Deadbolt
CTR	Door Controller
OVR	Mantrap door Override
IPTV	IP Monitor
PR	Passive Infrared
ML	Magnetic Lock
KB	Keybox
CR	Proximity Card Reader
CRK	Proximity Card Reader with PIN Keypad

6.0 Video Surveillance System

6.1 Installation Quality Inspection

The following are items to be inspected to verify they have been completed in accordance with the design specifications:

- Electrical and communications cables have been appropriately sized and selected to ensure that they will support currently installed and future equipment
- Cabling has been run in conduit, cable tray, raceway, above ceiling, below raised floors, in wall cavities or risers as detailed design documentation
- Conduit and cable trays have been effectively secured to ensure that they can support currently installed and future cabling;
- Connections have been correctly terminated and insulated to ensure satisfactory connectivity and protection against faults and interference;
- All IP cameras have been installed at the locations specified in the design documentation;
- Cameras of the specified type (e.g. colour, black and white, fixed, pan tilt zoom; multi-sensor, panoramic, thermal, etc.) have been installed
- Cameras have been correctly secured to protect against operational damage and ensure stability for continuous use;
- External cameras have been provided with adequate protection against moisture and other environmental conditions, through the use of Liquid tight conduit and connectors, proper installation of mounting hardware, gaskets, drip loops and Nema 4X, IP66 or IP67 backboxes

- Operator workstation CPU, LCD screen and peripheral devices have been installed at the specified location. Interconnecting cables have been protected from mechanical damage and have been permanently connected
- Associated equipment such as power supplies and switches have been connected correctly and secured appropriately.

6.2 Software Installation Inspection

The following are items to be inspected to verify the application software has been installed and configured on the video surveillance computing equipment.

- All software modules specified in the design documentation or the modules required to perform all specified operation functions have been installed and configured to meet system requirements
- The latest release version of all software modules including patches and upgrades have been provided
- Ensure that all IP cameras are running the latest firmware that is compatible with the Video Management Software (VMS), and any analytics packages that will be deployed as part of the install
- The control equipment hardware has sufficient capacity to support the software routines and functions under worst case demand conditions
- All cameras, system reports, GUI maps, screens and menus have been correctly configured
- Software has been registered to client.

6.3 Use Case Functional Test

The following tests shall be performed for each camera:

- Verify that the camera produces a clear picture with the specified resolution
- Verify that cameras having wide dynamic range are installed where specified, and the feature is enabled to allow the camera to capture the desired shot
- Verify that the camera maintains a clear picture and automatically compensates for changing light conditions including day/night change
- Verify that cameras provide complete and correct coverage of the area specified
- Verify that areas of the camera view may be masked to prevent unwanted alarm activation
- Verify that the camera anti-tampering feature has been enabled
- Simulate a tamper alarm and verify that the correct signal is transmitted to the operator workstation

- Simulate a video feed fault and verify that the correct signal is transmitted to the operator workstation
- Verify manually recording; very recording can be played, stopped, paused, rewinded, fast forwarded, advance frame by frame
- Verify that historical data reports may be generated in real-time
- Verify that real time video data analysis functions (record on motion, line cross detection recording, third party analytics, etc.) are performed in real time and the corresponding view displayed on the monitor
- Verify the video surveillance system interfaces with all additional security sub-systems so as intrusion detection, access control system, intercom system, Key Control management systems, etc., to display the correct camera view on the monitor when the corresponding signal is received.

7.0 Access Control System

7.1 Installation Quality Inspection

For all newly installed devices, the following are items to be inspected and verified for all doors, prior to completing the commission test, a visual inspection shall be completed. The inspection shall include:

- Electrical and communications cables have been appropriately sized and selected to ensure that they will support currently installed and future equipment
- Cabling has been run in conduit, cable tray, raceway, above ceiling, below raised floors, in wall cavities or risers as detailed design documentation
- Conduit and cable trays have been effectively secured to ensure that they can support currently installed and future cabling;
- Connections have been correctly terminated and insulated to ensure satisfactory connectivity and protection against faults and interference;
- Confirm reader is level, mounted securely and there are no visual gaps
- Confirm the Door position contact is installed securely in door frame, hole was not over drilled and there is no movement.
- For surface mount contacts, no large gaps and installed on the secure side of door.
- If present, weather stripping should not impede the contact
- Request to Exit device installed on security side of door
- Door Lever function matches door configuration, to provide security and code compliant egress
- Door closes securely with no rubbing or binding
- Readers have all screw caps installed
- ACU ID clearly visible on can

- Verify wiring is labeled… at ACU end labeled with end point device and door number/location identified; at devices location, the ACU the device is wired to, as well the end point device it feeds.

7.2 Software Installation Inspection

The following are items to be inspected to verify the application software has been installed and configured on the computing equipment.

- All software modules specified in the design documentation or the modules required to perform all specified operation functions have been installed and configured to meet system requirements.
- The latest release version of all software modules including patches and upgrades have been provided
- The control equipment hardware has sufficient capacity to support the software routines and functions under worst case demand conditions
- Software has been registered to client.

7.3 Use Case Tests

The use case tests are to certify that the doors functions as intended. The following tests as determined by door type will be performed on each door:

- Access Granted
- Door Held Test
- Door Forced Open
- Auto Operator
- Valid Egress

7.4 Doors with Magnetic Lock and Fire Alarm Interface

When a door(s) contains a magnetic lock, a fire alarm interface is required, thus it will need to be tested for functionality during the ULC verification process. A copy of the fire alarm verification is required before sign off of this door series type. The contractor to ensure proper testing is completed.

7.5 Power Loss Test

The test validation criteria is to ensure that the door functions as intended during an A/C power failure and a complete power failure. An A/C power failure must be simulated by disconnect the UPS feeding a POE powered ACU from A/C power, or power supply feeding the ACU from A/C power, and power supply feeding the door locks from A/C. For total power failures simulations POE power ACU must be disconnected from the POE switch; ACU and strikes feed by a standard power supply is disconnect from A/C and the backup battery is disconnected.

- During A/C power fail simulation, test that valid card presented during a power failure situation within the facility will allow access to be granted/denied/reported as tested above.
- During a total power failure, confirm that door fails in intended state. Doors with strike that are intended to fail secure, fail secure while still allowing code compliant egress. Magnetic lock doors must fail safe to meet code compliant egress.

7.6 Elevator Commissioning

The test validation criteria is to ensure that access to control floors is available to authorized card holders only, and elevator movement is tracked.

- Access granted only to floor credential authorized for
- Access denied to unauthorized floors
- Elevator Tracked

8.0 Intrusion Detection Commissioning

8.1 Installation Quality Inspection

The following items are to be inspected and verified that they have been completed in accordance with the design specifications:

- Electrical and communications cables have been appropriately sized and selected to ensure that they will support currently installed equipment and as per the manufacturer's recommendations and the University standards.
- Cabling has been run in conduit, cable tray, raceway, above ceiling, below raised floors, in wall cavities or risers as detailed design documentation

- Conduit and cable trays have been effectively secured to ensure that they can support currently installed and future cabling;
- Connections have been correctly terminated and insulated to ensure satisfactory connectivity and protection against faults and interference;
- All sensors have been installed at the locations specified in the design documentation;
- Sensors of the specified type (e.g. PIR, contact, sounder, photoelectric detector, glassbreak detector, shock sensors) have been installed at the locations specified in the design documentation
- Sensors have been correctly secured to protect against operational damage and ensure stability for continuous use
- Associated power supplies have been installed, connect to A/C and have backup batteries installed.
- Backup batteries have been labeled with an in-service date

8.2 Use Case Functional Test

The following tests shall be performed for each endpoint sensor as identified, as part of an intrusion walk test when the system is armed:

- Verify PIR sensor is detecting movement and reporting alarm condition
- Verify door contact sensor is detecting when the distance between the magnet and the reed switch is outside the manufacturer's specked distance. Confirm reporting alarm conditions when armed. Confirm all 24-hour doors go into alarm, while the overall intrusion detection system is disarmed. Confirm entry/exit delay on all designated entry doors
- Verify Glassbreak sensor is detecting a glass break and reporting alarm condition. All glassbreak test must be performed using the glassbreak manufacturer's glassbreak test kit
- Verify shock sensor is detecting vibration and reporting alarm conditions
- Verify sounder/speaker fires on alarm and reporting of alarm condition takes place
- Verify all non-24-hour end points, can armed and disarmed
- Simulate a wire cut by disconnect the circuitry to end point devices to simulate trouble conditions, and that the trouble condition is being reported correctly.
- Simulate an A/C failure and verify the trouble is reported correctly. Also, verify that the alarm system functions as intended both in an armed and disarmed state
- Ensure that each alarm condition tested, is capture and reported to a third-party and/or in-house monitoring station, via the primary communication method.

9.0 Duress Alarm Commissioning

9.1 Installation Quality Inspection

The following items are to be inspected and verified that they have been completed in accordance with the design specifications:

- Electrical and communications cables have been appropriately sized and selected to ensure that they will support currently installed equipment and as per the manufacturer's recommendations and the University standards.
- Cabling has been run in conduit, cable tray, raceway, above ceiling, below raised floors, in wall cavities or risers as detailed design documentation
- Conduit and cable trays have been effectively secured to ensure that they can support currently installed and future cabling;
- Connections have been correctly terminated and insulated to ensure satisfactory connectivity and protection against faults and interference;
- Panic buttons have been installed at the locations specified in the design documentation
- Panic buttons have been correctly secured to protect against operational damage and ensure stability for continuous use
- Annunciator consoles and/or workstation monitor have been installed at the locations specified in the design documentation
- Associated power supplies have been installed, connect to A/C and have backup batteries installed.
- Backup batteries have been labeled with an in-service date

9.2 Use Case Functional Test

The following tests shall be performed for each endpoint panic button as identified, as part of duress alarm walk test when the system:

- Verify panic button activation is reporting alarm condition
- Verify on panic button activation that the light outside the interview room is illuminated.
- Verify the alarm condition is being reported to the Annunciator console and/or workstation monitor, that a room location is being reported, and the room location is accurate.
- Verify that the alarm condition is being reported to campus police via Onyxworks

- Verify the alarm condition remains present on the Annunciator console and /or workstation, and the light outside the interview room door stays illuminated until the system is reset
- Simulate a wire cut by disconnect the circuitry to panic buttons to simulate trouble conditions, and that the trouble condition is being reported correctly.
- Simulate an A/C failure and verify the trouble is reported correctly.

10.0 Worksheets

- The worksheets that follow are to be reproduced on Tabloid (11” x 17”) sheets prior to the commencement of all inspections and testing.
- Results will be recorded in the worksheets and the worksheets will be reviewed and approved by the project lead prior to system acceptance.

Video Surveillance System Commissioning Worksheet

						Equipment Type								Commissioning Testing								Sign-off	
NO.	Termination Room	End Point Location	Name	Power Source	Indoor / Outdoor	Sinle Sensor	Multi-Sensor	Panoramic	PTZ	Thermal	People Counting	HARDWARE NOTES	SECURITY NOTES	Aimed	Focused	Blocking	Motion Recording	Tamper Detection	Access Control Sync	Intrusion Detection Sync	NOTES	Client Initials	Contractor Initials
Contractor Signature:																							
Contractor Signature:																							

Access Control Commissioning Worksheet

ROOM				ELECTRIC DOOR EQUIPMENT							ALIGMENT			Commissioning Testing							Sign-off	
NO.	NAME	Termination Room	Address	NO.	TYPE	DSS	RTE	LOCK	LBM	DPC	Latch/strike	HARDWARE NOTES	SECURITY NOTES	All Points Visible	Card Authorized	Card Denied	REX - Strike Release	Door Forced	Door Held	NOTES	Client Initials	Contractor Initials
Contractor Signature:																						
Contractor Signature:																						

Intrusion Detection Commissioning Worksheet

				Equipment Type											Commissioning Testing								Sign-off	
NO.	Termination Room	End Point Room	Zone Address	Door Contact	PIR	Glass Break	Shock Sensor	Photo-electric	Optex Laser	Fence Detect	Sounder	Smoke	HARDWARE NOTES	SECURITY NOTES	24 HR	Arm	Disarm	In-Alarm	Trouble	In-Alarm to 3rd Party Primary	In-Alarm to 3rd Party	NOTES	Client Initials	Contractor Initials
Contractor Signature:																								
Contractor Signature:																								

Duress Alarm Commissioning Worksheet

ROOM			Commissioning Testing								NOTES	Sign-off	
NO.	NAME	Termination Room	Button Activation	Light Activation	Annunciator display	On yourcells Notification	Alert Until Reset	Wire cut Trouble	AC Fail			Client Initials	Contractor Initials
Contractor Signature:													
Contractor Signature:													

Access Control Commissioning Worksheet

ROOM				ELECTRIC DOOR EQUIPMENT							ALIGMENT	HARDWARE NOTES	SECURITY NOTES	Commissioning Testing						NOTES	Sign-off	
NO.	NAME	Termination Room	Address	NO.	TYPE	DSS	RTE	LOCK	LBM	DPC	Latch/strike			All Points Visable	Card Authorized	Card Denied	REX - Strike Release	Door Forced	Door Held		Client Initials	Contractor Initials

Contractor Signature: ____________________

Client Signature: ____________________

Duress Alarm Commissioning Worksheet

ROOM			Commissioning Testing							NOTES	Sign-off	
NO.	NAME	Termination Room	Button Activation	Light Activation	Annunciator display	Onyxworks Notification	Alert Until Reset	Wire cut Trouble	AC Fail		Client Initials	Contractor Initials
Contractor Signature:												
Contractor Signature:												

Intrusion Detection Commissioning Worksheet

				Equipment Type											Commissioning Testing								Sign-off	
NO.	Termination Room	End Point Room	Zone Address	Door Contact	PIR	Glass Break	Shock Sensor	Photo-electric	Optex Laser	Fence Detect	Sounder	Smoke	HARDWARE NOTES	SECURITY NOTES	24 HR	Arm	Disarm	In-Alarm	Trouble	In-Alarm to 3rd Party Primary	In-Alarm to 3rd Party	NOTES	Client Initials	Contractor Initials

Contractor Signature:

Client Signature:

Video Surveillance System Commissioning Worksheet

						Equipment Type								Commissioning Testing								Sign-off	
NO.	Termination Room	End Point Location	Name	Power Source	Indoor / Outdoor	Sinle Sensor	Multi-Sensor	Panoramic	PTZ	Thermal	People Counting	HARDWARE NOTES	SECURITY NOTES	Aimed	Focused	Blocking	Motion Recording	Tamper Detection	Access Control Sync	Intrusion Detection Sync	NOTES	Client Initials	Contractor Initials

Contractor Signature:

Client Signature:

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