

HVAC Retrofit and Boiler Replacement - RHQ CLDC 21401-21/22-3812450

Project Manual

Mechanical Engineer:



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APPENDIX A
HAZARDOUS BUILDING MATERIALS ASSESSMENT

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

.1 Not Used.

1.2 ADMINISTRATIVE

- .1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative or Consultant.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting one day in advance of meeting date to Departmental Representative and Consultant.
- .4 Provide physical space and make arrangements for meetings.
- .5 Preside at meetings.
- .6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants, Departmental Representative and Consultant.
- .8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.3 PRECONSTRUCTION
MEETING

- .1 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Departmental Representative and Consultant, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.
- .4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
- .5 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work.
 - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .4 Not used.

- .5 Delivery schedule of specified equipment.
- .6 Not used.
- .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
- .8 Owner provided products.
- .9 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .10 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .12 Monthly progress claims, administrative procedures, photographs, hold backs.
- .13 Appointment of inspection and testing agencies or firms.
- .14 Insurances, transcript of policies.

1.4 PROGRESS MEETINGS

- .1 During course of Work, schedule progress meetings as required.
- .2 Contractor, major Subcontractors involved in Work and Departmental Representative and Consultant are to be in attendance.
- .3 Notify parties minimum 5 days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 3 days after meeting.
- .5 Agenda to include the following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work period.
 - .9 Review submittal schedules: expedite as required.
 - .10 Maintenance of quality standards.
 - .11 Review proposed changes for affect on construction schedule and on completion date.
 - .12 Other business.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

.1 Not used.

1.2 REFERENCES

.1 Not used.

1.3 ADMINISTRATIVE

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

1.4 SHOP DRAWINGS
AND PRODUCT DATA

- .1 Refer to CCDC 2 GC 3.10-2008.
- .2 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .3 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario where called for in other Sections.
- .4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .5 Allow 5 days for Departmental Representative's and Consultant's review of each submission.
- .6 Adjustments made on shop drawings by Departmental Representative or Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative and Consultant prior to proceeding with Work.
- .7 Make changes in shop drawings as Departmental Representative or Consultant may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative and Consultant in writing of revisions other than those requested.
- .8 Accompany submissions with transmittal letter, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .9 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.

- .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.
-
- .10 After Departmental Representative's and Consultant's review, distribute copies.
 - .11 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative or Consultant may reasonably request.
 - .12 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative or Consultant where shop drawings will not be prepared due to standardized manufacture of product.
 - .13 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative or Consultant.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
 - .14 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative or Consultant.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
 - .15 Submit electronic copies of manufacturer's instructions for requirements requested in specification Sections and as requested by Departmental Representative or Consultant.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
 - .16 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative or Consultant.
 - .17 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
 - .18 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative or Consultant.
 - .19 Delete information not applicable to project.

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| | .20 | Supplement standard information to provide details applicable to project. |
| | .21 | If upon review by Departmental Representative and Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed. |
| | .22 | The review of shop drawings is for sole purpose of ascertaining conformance with general concept.
.1 This review shall not mean that CSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades. |
| 1.5 SAMPLES | .1 | Not used. |
| 1.6 MOCK-UPS | .1 | Not used. |
| 1.7 PHOTOGRAPHIC DOCUMENTATION | .1 | Submit electronic copy of colour digital photography as directed by Departmental Representative or Consultant. |
| | .2 | Project identification: name and number of project and date of exposure indicated. |
| | .3 | Number of viewpoints: 4 locations.
.1 Viewpoints and their location as determined by Departmental Representative or Consultant. |
| 1.8 CERTIFICATES AND TRANSCRIPTS | .1 | Immediately after award of Contract, submit Workers' Compensation Board status. |
| | .2 | Submit transcription of insurance immediately after award of Contract. |

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Not Used.

1.2 REFERENCES

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Province of Ontario
 - .1 Occupational Health and Safety Act, R.S.O. 1990 Updated 2019.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3 Submit copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative, Consultant and authority having jurisdiction, weekly.
- .4 Submit copies of reports or directions issued by Federal and Provincial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit WHMIS MSDS - Material Safety Data Sheets.
- .7 Departmental Representative and Consultant will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 5 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative and Consultant within 5 days after receipt of comments from Departmental Representative and Consultant.
- .8 Departmental Representative's and Consultant's review of Contractor's final Health

		and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
	.9	Not used.
	.10	On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations. Include site-specific requirements.
1.4 FILING OF NOTICE	.1	File Notice of Project with Provincial authorities prior to beginning of Work.
1.5 SAFETY ASSESSMENT	.1	Perform site specific safety hazard assessment related to project.
1.6 MEETINGS	.1	Schedule and administer Health and Safety meeting with Departmental Representative and Consultant prior to commencement of Work.
1.7 REGULATORY REQUIREMENTS	.1	Not used.
1.8 PROJECT/SITE CONDITIONS	.1	Not used.
1.9 GENERAL REQUIREMENTS	.1	Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
	.2	Departmental Representative and Consultant may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.
1.10 RESPONSIBILITY	.1	Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

	.2	Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.
1.11 COMPLIANCE REQUIREMENTS	.1	Comply with Ontario Health and Safety Act, R.S.O.
	.2	Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.
1.12 UNFORSEEN HAZARDS	.1	When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative and Consultant verbally and in writing.
1.13 HEALTH AND SAFETY CO-ORDINATOR	.1	Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must: <ul style="list-style-type: none">.1 Have site-related working experience..2 Have working knowledge of occupational safety and health regulations..3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work..4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan..5 Be on site during execution of Work.
1.14 POSTING OF DOCUMENTS	.1	Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with Departmental Representative and Consultant.
1.15 CORRECTION OF NON-COMPLIANCE	.1	Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative and Consultant.
	.2	Provide Departmental Representative and Consultant with written report of action taken to correct non-compliance of health and safety issues identified.

	.3	Departmental Representative and Consultant may stop Work if non-compliance of health and safety regulations is not corrected.
1.16 BLASTING	.1	Blasting or other use of explosives is not permitted without prior receipt of written instruction by Consultant.
1.17 POWDER ACTUATED DEVICES	.1	Use powder actuated devices only after receipt of written permission from Consultant.
1.18 WORK STOPPAGE	.1	Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.
1.19 FIRE HYDRANTS	.1	Maintain fire hydrants in operating condition, free of snow and ice, accumulations, readily available and unobstructed for use in accordance with the Ontario Fire Code, O. Reg. 213/07.
PART 2 - PRODUCTS		
2.1 NOT USED	.1	Not used.
PART 3 - EXECUTION		
3.1 NOT USED	.1	Not used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Not used.

1.2 REFERENCES

- .1 Canadian Construction Documents Committee (CCDC)
 - .1 CCDC 2-2020, Stipulated Price Contract.

1.3 INSPECTION

- .1 Refer to CCDC 2, GC 2.3.
- .2 Allow Departmental Representative and/or Consultant access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .3 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative and/or Consultant instructions, or law of Place of Work.
- .4 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .5 Departmental Representative and/or Consultant will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction.

1.4 INDEPENDENT INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative and/or Consultant for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Departmental Representative.
- .2 Not used.

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| | .3 | Provide equipment required for executing inspection and testing by appointed agencies. |
| | .4 | Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents. |
| | .5 | If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative and/or Consultant at no cost to Departmental Representative and/or Consultant. Pay costs for retesting and reinspection. |
| 1.5 ACCESS TO WORK | .1 | Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants. |
| | .2 | Co-operate to provide reasonable facilities for such access. |
| 1.6 PROCEDURES | .1 | Notify appropriate agency and Departmental Representative and Consultant in advance of requirement for tests, in order that attendance arrangements can be made. |
| | .2 | Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work. |
| | .3 | Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples. |
| 1.7 REJECTED WORK | .1 | Refer to CCDC, GC 2.4. |
| | .2 | Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative and/or Consultant as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents. |
| | .3 | Make good other Contractor's work damaged by such removals or replacements promptly. |
| | .4 | If in opinion of Departmental Representative and/or Consultant it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Departmental Representative and/or Consultant. |

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| 1.8 REPORTS | .1 | Submit copies of inspection and test reports to Departmental Representative and Consultant. |
| | .2 | Provide copies to subcontractor of work being inspected or tested and/or manufacturer or fabricator of material being inspected or tested. |

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| 1.9 TESTS AND MIX
DESIGNS | .1 | Furnish test results and mix designs as requested. |
| | .2 | Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Departmental Representative and Consultant and may be authorized as recoverable. |

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| 1.10 MOCK-UPS | .1 | Not used. |
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| 1.11 MILL TESTS | .1 | Submit mill test certificates as required of specification Sections. |
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| 1.12 EQUIPMENT AND
SYSTEMS | .1 | Submit adjustment and balancing reports for mechanical and electrical systems. |
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PART 2 - PRODUCTS

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|--------------|----|-----------|
| 2.1 NOT USED | .1 | Not Used. |
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PART 3 - EXECUTION

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|--------------|----|-----------|
| 3.1 NOT USED | .1 | Not Used. |
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PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Not used.

1.2 REFERENCES

- .1 Canadian Construction Documents Committee (CCDC)
.1 CCDC 2-2008, Stipulated Price Contract.
- .2 Not used.
- .3 Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .4 If there is question as to whether products or systems are in conformance with applicable standards, Consultant reserves right to have such products or systems tested to prove or disprove conformance.
- .5 Cost for such testing will be born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance.

1.3 QUALITY

- .1 Not used.
- .2 Not used.
- .3 Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .4 Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.

- .5 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .6 Should disputes arise as to quality or fitness of products, decision rests strictly with Consultant based upon requirements of Contract Documents.
- .7 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .8 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.4 AVAILABILITY

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Departmental Representative and Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In event of failure to notify Departmental Representative and Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.5 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

	.8	Remove and replace damaged products at own expense and to satisfaction of Departmental Representative and Consultant.
	.9	Touch-up damaged factory finished surfaces to Departmental Representative's and Consultant's satisfaction. Use touch-up materials to match original. Do not paint over name plates.
1.6 TRANSPORTATION	.1	Pay costs of transportation of products required in performance of Work.
	.2	Transportation cost of products supplied by Owner will be paid for by Departmental Representative. Unload, handle and store such products.
1.7 MANUFACTURER'S INSTRUCTIONS	.1	Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
	.2	Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant will establish course of action.
	.3	Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.
1.8 QUALITY OF WORK	.1	Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
	.2	Do not employ anyone unskilled in their required duties. Departmental Representative and Consultant reserves right to require dismissal from site, workers deemed incompetent or careless.
	.3	Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative , whose decision is final.
1.9 CO-ORDINATION	.1	Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
	.2	Be responsible for coordination and placement of openings, sleeves and accessories.

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| 1.10 CONCEALMENT | .1 | In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise. |
| | .2 | Before installation inform Consultant if there is interference. Install as directed by Consultant. |
| 1.11 REMEDIAL WORK | | |
| | .1 | Refer to Section 01 73 00 - Execution. |
| | .2 | Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required. |
| | .3 | Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work. |
| 1.12 LOCATION OF FIXTURES | | |
| | .1 | Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate. |
| | .2 | Inform Consultant of conflicting installation. Install as directed. |
| 1.13 FASTENINGS | | |
| | .1 | Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise. |
| | .2 | Prevent electrolytic action between dissimilar metals and materials. |
| | .3 | Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section. |
| | .4 | Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable. |
| | .5 | Keep exposed fastenings to a minimum, space evenly and install neatly. |
| | .6 | Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable. |

1.14 FASTENINGS -
EQUIPMENT

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
- .3 Bolts may not project more than one diameter beyond nuts.
- .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

1.15 PROTECTION OF
WORK IN PROGRESS

- .1 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of Consultant.

1.16 EXISTING
UTILITIES

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants and pedestrian and vehicular traffic.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

- .1 Not used.

1.2 ACTION AND
INFORMATIONAL
SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit written request in advance of cutting or alteration which affects:
- .1 Structural integrity of elements of project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of operational elements.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate contractor.
- .3 Include in request:
- .1 Identification of project.
 - .2 Location and description of affected Work.
 - .3 Statement on necessity for cutting or alteration.
 - .4 Description of proposed Work, and products to be used.
 - .5 Alternatives to cutting and patching.
 - .6 Effect on Work of Owner or separate contractor.
 - .7 Written permission of affected separate contractor.
 - .8 Date and time work will be executed.

1.3 MATERIALS

- .1 Required for original installation.
- .2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00 - Submittal Procedures.

1.4 PREPARATION

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

- 1.5 EXECUTION
- .1 Execute cutting, fitting, and patching including excavation and fill, to complete Work.
 - .2 Fit several parts together, to integrate with other Work.
 - .3 Uncover Work to install ill-timed Work.
 - .4 Remove and replace defective and non-conforming Work.
 - .5 Remove samples of installed Work for testing .
 - .6 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
 - .7 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
 - .8 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
 - .9 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
 - .10 Restore work with new products in accordance with requirements of Contract Documents.
 - .11 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
 - .12 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material in accordance with Section 07 84 00 – Firestopping.
 - .13 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
 - .14 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

1.6 WASTE
MANAGEMENT AND
DISPOSAL

- .1 Not used.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

- .1 Not used.

1.2 REFERENCES

- .1 Canadian Construction Documents Committee (CCDC)
.1 CCDC 2-[2008], Stipulated Price Contract.

1.3 PROJECT
CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, [including] [] that caused by Owner or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by [Departmental Representative] []. Do not burn waste materials on site.
- .3 Clear snow and ice from access to building, [bank/pile snow in designated areas only] or [remove from site].
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Provide and use marked separate bins for recycling.
- .7 Dispose of waste materials and debris [] [off site].
- .8 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

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

1.4 FINAL CLEANING

- .1 [Refer to CCDC 2, GC 3.14].
- .2 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .3 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .4 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .5 Remove waste products and debris [other than] [] that caused by Owner or other Contractors.
- .6 Remove waste materials from site at regularly scheduled times or dispose of as directed by [Departmental Representative] []. Do not burn waste materials on site.
- .7 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .8 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .9 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, [and] floors.
- .10 Clean lighting reflectors, lenses, and other lighting surfaces.
- .11 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .12 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .13 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .14 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .15 Remove dirt and other disfiguration from exterior surfaces.
- .16 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .17 Sweep and wash clean paved areas.
- .18 Clean equipment and fixtures to sanitary condition; clean or replace filters of

mechanical equipment.

.19 Clean roofs, downspouts, and drainage systems.

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

.21 Remove snow and ice from access to building.

1.5 WASTE
MANAGEMENT AND
DISPOSAL

.1 Not Used.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

.1 Not Used.

1.2 REFERENCES

.1 Not Used.

1.3 ADMINISTRATIVE
REQUIREMENTS

- .1 Meet with Department Representative, to develop understanding of requirements of this section. Schedule meeting prior to contract completion, and at time designated by Department Representative.
- .2 The Department Representative will establish communication procedures for:
- .1 Notification of construction warranty defects.
 - .2 Determine priorities for type of defect.
 - .3 Determine reasonable time for response.
- .3 Provide name, telephone number and address of licensed and bonded company that is authorized to initiate and pursue construction warranty work action.
- .4 Ensure contact is located within local service area of warranted construction,

1.4 ACTION AND
INFORMATIONAL
SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Two weeks prior to Substantial Performance of the Work, submit to the Department Representative, three hard copies and one electronic copy of operating and maintenance manuals in English .
- .3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.
- .4 Provide evidence, if requested, for type, source and quality of products supplied.

1.5 FORMAT

- .1 Organize data as instructional manual.

- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
 - .3 When multiple binders are used correlate data into related consistent groupings.
 - .1 Identify contents of each binder on spine.
 - .4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
 - .5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.
 - .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
 - .7 Text: manufacturer's printed data, or typewritten data.
 - .8 Drawings: provide with reinforced punched binder tab.
 - .1 Bind in with text; fold larger drawings to size of text pages.
 - .9 Provide 1:1 scaled CAD files in dwg format on electronic drive.
- 1.6 CONTENTS -
PROJECT RECORD
DOCUMENTS
- .1 Table of Contents for Each Volume: provide title of project;
 - .1 Date of submission; names.
 - .2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.
 - .3 Schedule of products and systems, indexed to content of volume.
 - .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
 - .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
 - .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
 - .5 Typewritten Text: as required to supplement product data.
 - .1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.
- 1.7 AS -BUILT
DOCUMENTS AND
SAMPLES
- .1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.

1.8 RECORDING
INFORMATION ON
PROJECT RECORD
DOCUMENTS

- .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
-
- .2 Store record documents and samples in field office apart from documents used for construction.
 - .1 Provide files, racks, and secure storage.
 - .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.
 - .1 Label each document "PROJECT RECORD" in neat, large, printed letters.
 - .4 Maintain record documents in clean, dry and legible condition.
 - .1 Do not use record documents for construction purposes.
 - .5 Keep record documents and samples available for inspection by Departmental Representative and/or Consultant.
-
- .1 Prior to Substantial Performance of the Work, electronically transfer or provide on electronic drive the marked up information from the as-built documents to a master set of drawing files provided by the Construction Manager as follows:
 - .1 Drawings: AutoCAD latest release
 - .2 Specifications: .pdf format.
 - .3 Mark revised documents as "RECORD DOCUMENTS". Include all revisions, with special emphasis on electrical, structural wood, and reinforced concrete..
 - .4 Employ a competent computer drafts person to indicate changes on the electronic set of drawings. Provide updated record drawings in Adobe Acrobat and AutoCAD.
 - .5 Submit completed record documents to the Consultants on an electronic drive accompanied by three (3) hardcopy sets.
 - .2 Record information on set of black line opaque drawings, and in copy of Project Manual.
 - .3 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
 - .4 Record information concurrently with construction progress.
 - .1 Do not conceal Work until required information is recorded.
 - .5 Contract Drawings and shop drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.

- .5 Changes made by change orders.
- .6 Details not on original Contract Drawings.
- .7 References to related shop drawings and modifications.
- .6 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .7 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.
- .7 Provide digital photos, if requested, for site records.
- 1.9 FINAL SURVEY
 - .1 Submit final site survey certificate in accordance with Section 01 71 00 - Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.
- 1.10 EQUIPMENT AND SYSTEMS
 - .1 For each item of equipment and each system include description of unit or system, and component parts.
 - .1 Give function, normal operation characteristics and limiting conditions.
 - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
 - .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
 - .3 Include installed colour coded wiring diagrams.
 - .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
 - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
 - .2 Include summer, winter, and any special operating instructions.
 - .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - .6 Provide servicing and lubrication schedule, and list of lubricants required.
 - .7 Include manufacturer's printed operation and maintenance instructions.
 - .8 Include sequence of operation by controls manufacturer.
 - .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
 - .10 Provide installed control diagrams by controls manufacturer.

- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 - General Commissioning (Cx) Requirements.
- .15 Underground or Aboveground storage tank inspection documentation, registration, forms, decommissioning and removal in accordance with CEPA SOR/2008-197.
- .16 Additional requirements: as specified in individual specification sections.

1.11 MATERIALS AND FINISHES

- .1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
 - .1 Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional requirements: as specified in individual specifications sections.

1.12 MAINTENANCE MATERIALS

- .1 Spare Parts:
 - .1 Provide spare parts, in quantities specified in individual specification sections.
 - .2 Provide items of same manufacture and quality as items in Work.
 - .3 Deliver to location as directed; place and store.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Departmental Representative.
 - .2 Include approved listings in Maintenance Manual.
 - .5 Obtain receipt for delivered products and submit prior to final payment.
- .2 Extra Stock Materials:
 - .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
 - .2 Provide items of same manufacture and quality as items in Work.
 - .3 Deliver to location as directed; place and store.
 - .4 Receive and catalogue items.

- .1 Submit inventory listing to Departmental Representative .
 - .2 Include approved listings in Maintenance Manual.
 - .5 Obtain receipt for delivered products and submit prior to final payment.
 - .3 Special Tools:
 - .1 Provide special tools, in quantities specified in individual specification section.
 - .2 Provide items with tags identifying their associated function and equipment.
 - .3 Deliver to location as directed; place and store.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Departmental Representative .
 - .2 Include approved listings in Maintenance Manual.
- 1.13 DELIVERY,
STORAGE AND
HANDLING
- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
 - .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
 - .3 Store components subject to damage from weather in weatherproof enclosures.
 - .4 Store paints and freezable materials in a heated and ventilated room.
 - .5 Remove and replace damaged products at own expense and for review by Departmental Representative and/or Consultant.
- 1.14 WARRANTIES AND
BONDS
- .1 General Contractor to provide a written 1-year labour, and material warranty covering all items under this Work, unless stated elsewhere in the Specifications, commencing from the date of Substantial Performance.
 - .2 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
 - .3 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
 - .4 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
 - .5 Except for items put into use with Department Representative's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
 - .6 Verify that documents are in proper form, contain full information, and are notarized.
 - .7 Co-execute submittals when required.
 - .8 Retain warranties and bonds until time specified for submittal.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

1.1 GENERAL AND RELATED WORK

- .1 Read this Section in conjunction with all drawings and all other Sections so as to comply with the General Conditions of the Contract.
- .2 Site Conditions identifies all known hazardous building materials within the Project Area. The information provided is for general reference only.
 - .1 The specification fulfils the requirements of Section 30 of the Ontario Occupational Health and Safety Act.
 - .2 The specification fulfils the requirements of the Section 10 of Ontario Regulation 278/05.
- .3 The Outline of Work identifies the location, condition and quantities of hazardous building materials to be removed as part of this project. It should be read in conjunction with Appendix A – Hazardous Building Materials Assessment.

1.2 SITE CONDITIONS

- .1 As indicated in Appendix A – Hazardous Building Materials Assessment.

1.3 OUTLINE OF WORK

- .1 Follow recommendations in Appendix A – Hazardous Building Materials Assessment and all applicable law.

1.4 DEFINITIONS

- .1 Asbestos: Any of the fibrous silicates defined in Regulation 278/05 including: actinolite, amosite, anthophyllite, chrysotile, crocidolite and tremolite.
- .2 Asbestos-Containing Material (ACM): Material identified under Site Conditions including any debris, overspray, fallen material and settled dust.
- .3 Fitting: Individual segments or pieces of a mechanical service line which may include but is not limited to the hangers, tees, elbows, joints, valves, unions, etc.
- .4 Friable Material: Material that when dry can be crumbled, pulverized or powdered by hand pressure and includes such material that is crumbled, pulverized or powdered.
- .5 HEPA: High Efficiency Particulate Aerosol filter that is at least 99.97 percent efficient in collecting a 0.3 micrometre aerosol.
- .6 Lead-Containing: The Ontario Ministry of Labour (MOL) has not established a lower limit for concentrations of lead in paint, below which precautions do not need to be considered during construction projects. Pinchin follows the recommendations of the Environmental Abatement Council of Ontario (EACO) Lead Guideline for Construction, Renovation, Maintenance or Repair. The Guideline suggests that 0.1% (1,000 ppm) lead in paint represents a de minimis concentration of lead in paint for construction hygiene purposes, that is a concentration below which the lead content is not the limiting hazard in any disturbance of leaded paint for non-aggressive disturbance of painted finishes, (hand powered demolition, chipping, scraping, light sanding, etc.).

- .7 Non-Friable Material: Material that when dry cannot be crumbled, pulverized or powdered by hand pressure.
 - .8 PCBs: Monochlorinated or Polychlorinated Biphenyls (or any mixture of both).
 - .9 PCB Material: means solid material containing PCBs at a concentration of more than fifty milligrams per kilogram (mg/kg) or 50 parts per million (ppm), or liquid with greater than 2 mg/kg or ppm.
- 1.5 REGULATIONS AND GUIDELINES
- .1 Comply with Federal, Provincial, and local requirements, provided that in any case of conflict among those requirements or with these Specifications, the more stringent requirements shall apply. Work shall be performed under regulations in effect at the time work is performed.
 - .2 Where regulations are not present, follow accepted industry standards and applicable Guideline documents.
 - .3 Regulations and Guidelines include but are not limited to the following:
 - .1 Ministry of Labour Occupational Health and Safety Act Regulations for Construction Projects including Revised Statutes of Ontario 1990, Chapter 0.1 and Ontario Regulation 278/05.
 - .2 Ministry of the Environment and Climate Change Regulation for the disposal of waste, including R.R.O. 1990, Reg. 347 as amended.
 - .3 PCB Regulations, SOR 2008-273 and R.R.O. 1990, Reg 362.
 - .4 Regulation 490/09 Designated Substances.
 - .5 Environmental Abatement Council of Ontario (EACO), Lead Guideline For Construction, Renovation, Maintenance or Repair, October 2014.
 - .6 Ministry of Labour, Guideline, Silica on Construction Projects, 2011.
- 1.6 QUALITY ASSURANCE
- .1 Removal and handling of hazardous materials is to be performed by persons trained in the methods, procedures and industry practices for Abatement.
 - .2 Complete work so that at no time airborne dust, visible debris, or water runoff contaminate areas outside the Work Area.
 - .3 All work involving electrical, mechanical, carpentry, glazing, etc., shall be performed by licensed persons experienced and qualified for the work required.
- 1.7 NOTIFICATION
- .1 Before commencing work, notify orally and in writing, an inspector at the office of the Ontario Ministry of Labour nearest the project site, where required.
 - .2 Inform all trades on site of the presence and location of hazardous materials identified in the Contract documents.
 - .3 Notify the Owner or Owner's Representative, the Joint Occupational Health and Safety Committee and the Provincial Ministry of Labour, if suspected asbestos-containing materials not identified in the contract documents

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

PART 1 - GENERAL

1.1 RELATED
REQUIREMENTS

- .1 Not used.

1.2 ACTION AND
INFORMATIONAL
SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings to show:
- .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .3 Shop drawings and product data accompanied by:
- .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .6 Closeout Submittals:
- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with the CSC Rep before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to CSC Rep for approval. Submission of individual data will not be accepted unless directed by CSC Rep.
 - .2 Make changes as required and re-submit as directed by CSC Rep.
 - .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during (Cont'd)

- specified demonstrations and instructions.
- .8 Site records:
 - .1 Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Consultant for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 QUALITY ASSURANCE

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

1.4 MAINTENANCE

- .1 Not used.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

1.5 DEFINITIONS

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.
- .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.

- .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with Consultant.
- .8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS", and "DDC" generally mean same.
- .9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.
- .10 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
- .11 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .12 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .13 "Consultant" – means person, firm, corporation identified as such in Agreement, or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.6 GENERAL SCOPE

- .1 The scope of Section 21 Fire Suppression, Section 22 Plumbing, Section 23 HVAC, and Section 25 Control is for building services within the project structure and 1m from the building.
- .2 Provide complete, fully tested, and operational systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.
- .3 Contract documents and drawings of this Division are diagrammatic and approximately, to scale unless detailed otherwise. They establish scope, material, and installation quality but are not detailed installation instructions.

- .4 Follow manufacturers' recommended installation instructions, details, and procedures for equipment, supplemented by requirements of the Contract Documents.
- .5 Install equipment generally in locations and routes indicated. Run piping and ductwork close to building structure, parallel to building lines, maximize headroom and maintain minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Consultant at no extra cost.
- .6 For work within existing facilities, confirm locations and elevations of existing piping and equipment prior to commencement of new work.
- .7 Install equipment to provide service access, maintain service clearances and for ease of maintenance.
- .8 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start up and test.
- .9 Install control valves, control dampers, thermal wells, and other devices on piping and ductwork, furnished by Division 25.
- 1.7 COORDINATION OF WORK
 - .1 Cooperate and coordinate with other trades on the project.
 - .2 Make reference to electrical, mechanical, structural, and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.
 - .3 Where dimensional details are required, work with the applicable architectural and structural drawings.
 - .4 Full size and detailed drawings shall take precedence over scale measurements from drawings. Specifications shall take precedence over drawings.
 - .5 Any areas indicated as space for future materials or equipment shall be left clear.
- 1.8 DRAWINGS AND SPECIFICATIONS
 - .1 Drawings and specifications are complementary to each other, and what is called for by one shall be binding as if called for by both.
 - .2 Should any discrepancy appear between drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of the plans, and specifications, obtain written clarification from the Consultant during the tender period. Without a written clarification, the better quality and/or greater quantity of work or materials shall be estimated, performed and furnished within the tendered price.
 - .3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.
- 1.9 PERMITS AND FEES
 - .1 All work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

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| | .2 | Obtain all permits and pay all fees applicable to the scope of work. |
| | .3 | Contractor shall arrange for inspections of the work by the |
| 1.10 EXAMINATION OF SITE | .1 | Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or known to exist at the time of tender. |
| PART 2 - PRODUCTS | | |
| 2.1 EQUIPMENT AND MATERIALS | .1 | Materials and equipment installed shall be new, CSA approved and of quality specified. |
| | .2 | Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place. |
| | .3 | Where two or more products of the same type are required, products shall be of the same manufacturer. |
| | .4 | Notify the Consultant in writing ten (10) days prior to the tender close, any materials or equipment specified which is not currently available or will not be available for use as called for herein. Failing this, the contract will assume that the most expensive alternate has been included in the tender price. |
| | .5 | All equipment supplied to the project will meet efficiencies as defined in ASHRAE Standard 90.1 and NECB (current versions) |
| 2.2 FIRE STOPPING AND SMOKE SEALS | .1 | Provide fire stopping and smoke seals in accordance with Division 07 – Fire Stopping and Section 22 07 11. If the requirements for fire stopping of mechanical services penetrations of Section 22 07 11 differ from the requirements of Division 07, the most stringent requirements shall apply. |
| 2.3 ACCESS DOORS | .1 | General |
| | .1 | Provide access doors for maintenance or adjustment of all parts of the mechanical system. This shall apply but not be limited to valves, dampers, cleanouts and controls. |
| | .2 | Where equipment is concealed by a T-bar ceiling, the location of equipment shall be indicated by coloured markings. Refer to Section 23 05 53 Identification for Mechanical Piping and Equipment. |
| | .3 | Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed. |
| | .4 | Provide stainless steel doors in walls of washrooms, kitchen, janitor rooms and laundry rooms. |
| | .5 | Provide Drywall type access doors in all public drywall spaces requiring access to equipment. |
| | .6 | All fasteners on access panels shall be tamper proof, contractor shall provide three (3) sets of keys. |
| | .7 | Locate all access doors outside of secure areas where possible. Where not possible, review the locations of panels with the Owner's Consultant prior to installation. All access panels within secure areas are to be of penal quality, lockable, vandal-proof and ligature resistant. |

- .8 Provide 300 mm x 300 mm minimum size for inspection and hand access.
- .9 600 mm x 600 mm minimum size, larger if indicated on drawings, where entry is required and access is difficult.
- .10 Size to suit masonry modules when located in a masonry wall.
- .11 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface material and pattern if this is available at the time the units are ordered.
- .12 Security Access Doors:
 - .1 Access doors for security areas shall be 1.70 mm [14 gauge] thick double skinned internally reinforced at 150 mm [6"] on centre, 4.76 mm [3/16"] thick, insulated in pressed sink wiped cold rolled steel metal frame (similar to door frame) complete with necessary preparation to receive security lock escutcheon and hinges.
- .2 Submittals:
 - .1 Submit shop drawings for all access doors anticipated on this project.
- .3 Products:
 - .1 Drywall Surface: Extruded aluminum frame with gypsum board inlay and structural corner elements. Hinge to be concealed 2-point hinge, non-corroding with screwdriver operated cam latch.
 - .2 Masonry Surface: Universal design, steel door (16ga) and steel frame (18ga), door flush to frame, rounded safety corners, continuous concealed hinge, screwdriver operated cam latch, prime coat grey painted finish.
 - .3 Tile Surface: Universal design, stainless steel door (16ga) and stainless steel frame (18ga), door flush to frame, rounded safety corners, continuous concealed hinge, screwdriver operated cam latch, #4 satin stainless steel finish.
 - .4 Plaster Walls and Ceiling: steel door (14ga) and steel frame (14ga), door flush to frame edge, expansion casing bead and 75 mm wide galvanized lath surround recessed 18 mm to receive plaster, continuous concealed hinge, screwdriver operated cam latch, prime coat grey painted finish.
 - .5 Acoustic Plaster: Steel door (16ga) and steel frame (14ga), door recessed 12 mm lined with self-furring lath, 75 mm wide galvanized lath surround recessed 18 mm to receive plaster flush to frame edge, concealed pivoting rod type hinge, screwdriver operated cam latch, prime coat grey painted finish.
 - .6 Acoustical Tile Ceilings: Steel door (16ga) and steel frame (14ga), door recessed 25 mm to receive acoustic tile, concealed pivoting rod type hinge, screwdriver operated cam latch, prime coat grey painted finish.
 - .7 Fire Rated Walls:
 - .1 Non-combustible construction: Uninsulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 2 hour 'B' label.
 - .2 Combustible construction: Insulated steel door (20ga) for maximum 250°C rise after 30 minutes and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 1-1/2 hour 'B' label.
 - .8 Fire Rated Ceilings: 50mm Insulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed upswing self closing hinge, L handle latch, white

		baked enamel finish, size 600mm x 600mm (24" x 24") ULC rated 2 hour 'B' label.
	.9	Ductwork: Ultra low leakage type, flat oval design, galvanized steel frame (22ga), double skin galvanized steel door (22 ga) with 25mm insulation fully enclosed in panel, bulb type seal integrally fastened to door, lever cam locks. Provide stainless steel in lieu of galvanized steel in stainless steel ductwork.
2.4 MOTOR STARTERS AND ACCESSORIES	.1	Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.
	.2	Unless otherwise specified, starters for 1-phase motors are to be 115 volt; thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate contactor controlled by a separate H-O-A switch in an enclosure as specified.
	.3	Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage nonreversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a separate contactor controlled by a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
	.4	Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings: .1 Enclosures located in sprinklered areas – Type 2; .2 Enclosures exposed to the elements – Type 3R, constructed of stainless steel; .3 Enclosures inside the building in wet areas – Type 3R, constructed of stainless steel; .4 Enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application; .5 Enclosures except as noted above – Type 1; .6 Enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.
	.5	Disconnect switches for motors are to be heavy-duty, CSA certified, front operated switches, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.
	.6	Fuses are to be, unless otherwise scheduled or specified, HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.
2.5 PIPE SLEEVES	.1	Pipe sleeves shall be provided for piping passing through walls and floors. Minimum schedule 40 steel pipes or factory fabricated, flanged, high-density polyethylene sleeves with reinforced nail bosses. Sleeves shall extend 25 mm on either side of the wall.
	.2	Schedule 40 steel pipes shall be used as floor pipe sleeves in wet areas with a 50 mm upstand.
	.3	Review and coordinate sleeve diameters with fire stop installation details as

		applicable.
2.6 WATER PROOFING MATERIALS	.4	Pipe sleeves are not required where pipes pass through cored concrete walls or floors.
	.1	Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
	.2	Acceptable products are: .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316; .2 The Metraflex Co. "MetraSeal" type ES
2.7 ESCUTCHEONS AND PLATES	.1	Provide escutcheons and plates on all piping and ductwork passing through finished walls, floors and ceilings.
	.2	Escutcheons shall be one piece, stainless or chrome plated steel.
PART 3 - EXECUTION		
3.1 PAINTING REPAIRS AND RESTORATION	.1	Not used.
	.2	Prime and touch up marred finished paintwork to match original.
	.3	Restore to new condition, finishes which have been removed or damaged.
	.4	Clean exposed bare metal surfaces supplied under Divisions 21, 22, 23 and 25. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.
	.5	Paint all pipe hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer.
3.2 CLEANING	.1	During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
	.2	Clean equipment and devices installed as part of this project.
3.3 FIELD QUALITY CONTROL	.1	All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Consultant.
	.2	Work, which does not conform to standards accepted by the Consultant and the trade, may be rejected by the Consultant. The Contractor
	.2	Manufacturer's Field Services: .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS. .2 Provide manufacturer's field services consisting of product use recommendations

and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 DEMONSTRATION

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

.2 Trial usage to apply to following equipment and systems:

.1 Boiler Array.

.2 Heating and boiler pumps.

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

.4 Use operation and maintenance manual and as-built drawings as part of instruction materials.

3.5 PROTECTION

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

3.6 CUTTING, PATCHING AND CORING

.1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Perform x-rays and obtain written approval from the Structural Consultant before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field cut smaller than 100 mm.

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

.6 Removal of any existing pipe, conduit, or ductwork within a slab core hole or slab opening through floors and roofs must be removed completely, including any associated sleeving, in a safe manner. Provisions are to be made during the removal process to protect any occupants and/or fabric of the space below. The Consultant is to be advised of all existing mechanical service penetration locations, such that site visits and field reviews can be fully co-ordinated and undertaken before and after the opening is closed in and filled.

.7 Filling of any existing slab core or opening is to be with an engineered design of concrete fill complete with doweling for adhesion and/or fire stopping system as appropriate.

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| | .7 | Filling of any existing slab core or opening is to be with an engineered design of concrete fill complete with doweling for adhesion and/or fire stopping system as appropriate. |
| 3.8 EXCAVATION AND BACKFILL | .1 | Refer to the requirements of Division 31. |
| | .2 | Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting. |
| | .3 | Refer to drawing details as applicable. |
| 3.9 INSTALLATION OF EQUIPMENT | .1 | Pipe all equipment drains to building drains except systems containing glycol. |
| | .2 | Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment. |
| | .3 | Maintain permanent access to equipment for maintenance. |
| 3.10 TESTS | .1 | Insulate or conceal work only after testing and acceptance by CSC Representative and Consultant. |
| | .2 | Conduct tests in presence of CSC representative. |
| | .3 | Piping: <ul style="list-style-type: none">.1 General: Maintain test pressure without loss for 48 hours unless otherwise specified..2 Hydraulically test hydronic piping systems at 1-1/2 times system operating pressure or minimum 1300 kPa, whichever is greater..3 Test natural gas systems to latest edition of CAN-B149.1 and requirements of Authorities Having Jurisdiction. |

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS	.1	Not used.
1.2 REFERENCES	.1	The latest revisions of the following standards shall apply unless noted otherwise.
	.2	Canadian General Standards Board (CGSB)
	.1	CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
	.3	National Fire Code of Canada.
1.3 ACTION AND INFORMATIONAL SUBMITTALS	.1	Not used.
1.4 QUALITY ASSURANCE	.1	Not used.
1.5 DELIVERY, STORAGE AND HANDLING	.1	Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
	.2	Delivery and Acceptance Requirements:
	.1	Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

PART 2 - PRODUCTS

2.1 MATERIAL	.1	Not used.
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PART 3 - EXECUTION

3.1 APPLICATION	.1	Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
3.2 CONNECTIONS TO EQUIPMENT	.1	In accordance with manufacturer's instructions unless otherwise indicated.
	.2	Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

	.1	Unions are not required in installations using grooved mechanical couplings (the coupling shall serve as the union).
	.3	Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
	.4	The flexible ground joint couplings may be used in lieu of a flexible connector at equipment connections for vibration attenuation and stress relief, coupling shall be placed in close proximity to the source of vibration.
3.3 CLEARANCES	.1	Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
	.2	Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.
3.4 DRAINS	.1	Install piping with grade in direction of flow except as indicated.
	.2	Install drain valve at low points in piping systems, at equipment and at section isolating valves.
	.3	Pipe each drain valve discharge separately to above floor drain.
	.1	Discharge to be visible.
	.4	Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.
3.5 AIR VENTS	.1	Install manual air vents to at high points in piping systems.
	.2	Install isolating valve at each automatic air valve.
	.3	Install drain piping to approved location and terminate where discharge is visible.
3.6 DIELECTRIC COUPLINGS	.1	General: compatible with system, to suit pressure rating of system.
	.2	Locations: where dissimilar metals are joined.
	.3	NPS 2 and under: isolating unions or bronze valves.
	.4	Over NPS 2: isolating flanges.
3.7 PIPEWORK INSTALLATION	.1	Install pipework to CAN/CSA-B214 and by certified journey person.
	.2	Screwed fittings jointed with Teflon tape.
	.3	Protect openings against entry of foreign material.

- .4 Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions.
 - .1 Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.
 - .2 The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
- .5 Push-to-connect piping: Prepare copper tube and install in strict accordance with installation instructions. Pipe ends shall be cleaned, free from indentations, projections, burrs and foreign matter. Use a tube preparation tool as supplied by the manufacturer to clean and make installation mark. Push copper tube into fittings to installation depth mark, per installation instructions. Keep fittings free of dirt and oil.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves on chilled water and related condenser water systems only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .9 Install ball valves for glycol service.
 - .10 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.
- 3.8 SLEEVES
 - .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
 - .2 Material: schedule 40 black steel pipe.
 - .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
 - .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
 - .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
 - .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for firestopping.
 - .2 Maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.
- 3.9 ESCUTCHEONS
 - .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
 - .2 Construction: one piece type with set screws.
 - .1 Chrome or nickel plated brass or type 302 stainless steel..
 - .3 Sizes: outside diameter to cover opening or sleeve.
 - .1 Inside diameter to fit around pipe or outside of insulation if so provided.
- 3.10 PREPARATION FOR FIRE STOPPING
 - .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
 - .2 Uninsulated unheated pipes not subject to movement: no special preparation.
 - .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
 - .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

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| 3.11 FLUSHING OUT
OF PIPING SYSTEMS | .1 | In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems. |
| | .2 | Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant Division 23 sections. |
| | .3 | Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems. |
| 3.12 PRESSURE
TESTING OF
EQUIPMENT AND
PIPEWORK | .1 | Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.. |
| | .2 | Pipework: test as specified in relevant Division 23 sections. |
| | .3 | System piping and components shall be tested to withstand 420 kPa (60 psi) or 1.5 times the operating pressure, whichever is greater, for at least 4 h with no loss of pressure. |
| | .4 | Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media. |
| | .5 | Conduct tests in presence of Departmental Representative. |
| | .6 | Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate. |
| | .7 | Insulate or conceal work only after approval and certification of tests by Consultant. |
| 3.13 EXISTING
SYSTEMS | .1 | Connect into existing piping systems at times approved by Departmental Representative. |
| | .2 | Request written approval by Departmental Representative 10 days minimum, prior to commencement of work. |
| | .3 | Be responsible for damage to existing plant by this work. |
| 3.14 CLEANING | .1 | Clean in accordance with Section 01 74 11 - Cleaning. |
| | .1 | Remove surplus materials, excess materials, rubbish, tools and equipment. |
| | . | |

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Not used.
- 1.2 REFERENCES .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 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.
- .3 Canadian General Standards Board (CGSB).
- .1 CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self-Indicating, Commercial/Industrial Type.
- .2 CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit manufacturer's product data for following items:
- .1 Thermometers.
- .2 Pressure gauges.
- .3 Stop cocks.
- .4 Syphons.
- .5 Wells.
- .3 Product Data:
- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- 1.4 HEALTH AND SAFETY .1 Not used.
- 1.5 WASTE MANAGEMENT AND DISPOSAL .1 Not used.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Design point to be at mid-point of scale or range.
- 2.2 DIRECT READING THERMOMETERS .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB 14.4 or ASME B 40- 200.
- 2.3 REMOTE READING THERMOMETERS .1 100mm diameter liquid filled or vapor activated dial type: to CAN/CG SB - 14.4 or ASME B40-200, accuracy within one scale division. Brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb, and polished brass or

		stainless steel case for wall mounting.
2.4 THERMOMETER WELLS	.1	Copper pipe: copper or bronze.
	.2	Steel pipe: brass.
2.5 PRESSURE GAUGES	.1	112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel or phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
	.2	Provide:
	.1	Siphon for steam service.
	.2	Snubber for pulsating operation.
	.3	Diaphragm assembly for corrosive service.
	.4	Gasketed pressure relief back with solid front.
	.5	Bronze ball valve.
	.6	Oil filled for high vibration applications.
PART 3 - EXECUTION		
3.1 GENERAL	.1	Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
	.2	Install between equipment and first fitting or valve.
3.2 THERMOMETERS	.1	Install in wells on piping. Provide heat conductive material inside well.
	.2	Install in locations as indicated and on inlet and outlet of:
	.1	Heat exchangers.
	.2	Heating and cooling coils..
	.3	Water boilers.
	.3	Install wells for balancing purposes.
	.4	Use extensions where thermometers are installed through insulation.
3.3 PRESSURE GAUGES	.1	Install in following locations:
	.1	Upstream and downstream of PRV's.
	.2	Upstream and downstream of control valves.
	.3	Inlet and outlet of coils.
	.4	Inlet and outlet of heat exchanger.
	.5	Outlet of boilers.
	.6	In other locations as indicated.
	.2	Install bronze ball valves.
	.3	Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

- .1 Install engraved lamicaid nameplates as specified in Section 23 05 53.01 - Mechanical Identification, identifying medium.

PART 1 - GENERAL

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| 1.1 RELATED REQUIREMENTS | .1 | Not Used. |
| 1.2 REFERENCES | .1 | The latest revisions of the following standards shall apply unless noted otherwise. |
| | .2 | American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME). |
| | .1 | ANSI/ASME B16.1-, Cast Iron Pipe Flanges and Flanged Fittings. |
| | .3 | American Society for Testing and Materials International (ASTM). |
| | .1 | ASTM A49, Specification for Heat-Treated Carbon Steel Joint Bars. |
| | .2 | ASTM A126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings. |
| | .3 | ASTM B61, Specification for Steam or Valve Bronze Castings. |
| | .4 | ASTM B62, Specification for Composition Bronze or Ounce Metal Castings. |
| | .5 | ASTM B85, Specification for Aluminum-Alloy Die Castings. |
| | .6 | ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate. |
| | .7 | ASTM B21/B21M, Standard Specification for Naval Brass Rod, Bar, and Shapes. |
| | .8 | ASTM B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes. |
| | .9 | ASTM B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes. |
| | .4 | Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS). |
| | .1 | MSS SP-67 Butterfly Valves. |
| | .2 | MSS SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends. |
| | .3 | MSS SP-71, Grey Iron Swing Check Valves, Flanged and Threaded Ends. |
| | .4 | MSS SP-82, Valve Pressure Testing Methods. |
| | .5 | MSS SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends. |
| 1.3 ACTION AND INFORMATIONAL SUBMITTALS | .1 | Provide submittals in accordance with Section 01 33 00 - Submittal Procedures. |
| | .2 | Product Data: |
| | .1 | Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures. |
| | .2 | Submit data for valves specified in this section. |
| 1.4 CLOSEOUT | .1 | Submit maintenance data for incorporation into manual specified in Section 01 78 00 |

SUBMITTALS

- Closeout Submittals.

1.5 DELIVERY,
STORAGE AND
HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE
MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

PART 2 - PRODUCTS

2.1 BALL VALVES

- .1 Isolating Service and Throttling Service NPS 50 and small:
 - .1 Body and Trim: bronze.
 - .2 Stem: brass.
 - .3 Connection: screwed ends.
 - .4 Seats: buna up to 90°C, Viton up to 150°C.
 - .5 Ball: brass chrome plated.

2.2 BUTTERFLY VALVES

- .1 General Use:
 - .1 Body: cast iron.
 - .2 Liner: EPDM.
 - .3 Stem: stainless steel.
 - .4 Disc: stainless steel.
 - .5 Connections: flanged or grooved ends.
- .2 Heating Systems with temperature 93°C and greater:
 - .1 Body: cast iron.
 - .2 Liner: rated for continuous operation at 115°C.

- .3 Stem: stainless steel.
 - .4 Disc: stainless steel.
 - .5 Connections: flanged or grooved ends.
 - .3 Isolation Use:
 - .1 Body: wafer style.
 - .2 Liner: EPDM.
 - .3 Stem: stainless steel.
 - .4 Disc: stainless steel.
 - .5 Connections: threaded lugs.
- 2.3 GLOBE AND ANGLE GLOBE VALVES
- .1 Throttling Service and Steam Services NPS 50 and smaller:
 - .1 Body: bronze with union bonnet.
 - .2 Stem: Rising.
 - .3 Disc and Seat Ring: Stainless steel.
 - .4 Connections: soldered or screwed ends.
 - .2 Isolation Service up to NPS 50:
 - .1 Body: bronze with union bonnet.
 - .2 Stem: Rising.
 - .3 Disc: renewable composition.
 - .4 Connections: soldered or screwed ends.
 - .3 Isolation Service above NPS 50:
 - .1 Body: cast iron.
 - .2 Trim: bronze.
 - .3 Stem: Rising OS&Y.
 - .4 Disc: bronze or cast iron beveled.
 - .5 Connections: flanged ends.
- 2.4 CHECK VALVES
- .1 Swing Check Valve NPS 50 and smaller:
 - .1 Body: bronze Y pattern.
 - .2 Trim: bronze.
 - .3 Disc: swing.
 - .4 Connections: soldered or screwed ends.
 - .2 Swing Check Valve NPS 65 and larger:
 - .1 Body: iron Y pattern.
 - .2 Trim: bronze.
 - .3 Disc: renewable.
 - .4 Connections: flanged ends.
 - .3 Wafer Check Valve NPS 65 and larger:
 - .1 Body: cast iron.
 - .2 Trim: bronze.
 - .3 Connections: threaded lugs.
 - .4 Lift Check Valve NPS 65 and larger:

		.1	Body: cast iron.
		.2	Trim: bronze.
		.3	Connections: flanged ends.
		.4	Use: vertical piping.
2.5 SPRING LOADED CHECK VALVES	.1	NPS 50 and smaller:	
		.1	Body: bronze.
		.2	Stem: brass.
		.3	Spring: beryllium copper.
		.4	Disc and Seat: Teflon.
		.5	Connections: screwed ends.
	.2	Larger than NPS 50:	
		.1	Body: cast iron.
		.2	Seat: bronze.
		.3	Spring: stainless steel.
		.4	Plug: bronze.
		.5	Connections: flanged ends.
2.6 CIRCUIT BALANCING VALVES	.1	Body Design: suitable for throttling.	
	.2	Construction: all metal parts non-ferrous, pressure die cast, non-porous copper alloy.	
	.3	Installation: designed to be installed in any direction without affecting flow measurement.	
	.4	Functions:	
		.1	Precise flow measurement $\pm 2\%$.
		.2	Precision flow balancing.
		.3	Positive shut-off with no drip seat and teflon disc.
		.4	Drain connections with protective cap.
	.5	Balancing Connection: "hidden memory" feature to program valve with precision tamper-proof balancing setting.	
	.6	Meter Connection: fittings for connecting a portable differential pressure meter and positive shut-off cocks for each meter connection.	
2.7 PLUG COCKS	.1	NPS 50 and smaller:	
		.1	Body: cast iron.
		.2	Plugs and Washers: brass.
		.3	Connection: screwed ends.
	.2	Larger than NPS 50.	
		.1	Body: cast iron.
		.2	Plug: cast iron.
		.3	Lubrication: pressure lubricated.
		.4	Connection: flanged ends.

2.8 DRAIN VALVES

- .1 Globe Type Drain Valves:
 - .1 Body: bronze.
 - .2 Disc: compression stop.
 - .3 Ends: nipple and cap or hose.
- .2 Ball Type Drain Valves:
 - .1 Body: bronze.
 - .2 Ends: cap and chain.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.

3.2 VALVE OPERATORS

- .1 Provide suitable die-cast handwheels for gate, globe, ball, butterfly, drain valves and inside hose bibbs.
- .2 Supply one 1 plug cock wrench for every ten 10 plug cocks 50 mm and smaller, supply wrench and set screws with each plug cock 65 mm and larger.
- .3 Provide latch lock throttling handle for butterfly valves 150 mm and smaller and gear operators for 200 mm and larger.

3.3 VALVE SCHEDULE

- .1 Provide valves as indicated on drawings and following schedule:
 - .1 Globe and Angle Globe Valves:
 - .1 Throttling service.
 - .2 Control device.
 - .3 Meter bypass.
 - .2 Ball and Quick Opening Valves:
 - .1 Shut-off and isolation.
 - .2 Isolating service
 - .3 Heating system water.
 - .3 Butterfly Valves:
 - .1 Interchangeable with gate and globe valves in water systems only. Use butterfly valves only in MECHANICAL ROOMS.
 - .4 Swing Check Valves:
 - .1 Discharge or pumps.
 - .5 Spring Loaded Check Valves:
 - .1 Discharge of condenser water pumps.
 - .2 Condensate pumps.
 - .6 Circuit Balancing Valves:
 - .1 On hydronic piping systems where shown on drawings and details.
 - .7 Hose Bibbs:
 - .1 Shut-off valve for water service.
 - .8 Non-Lubricated Plug Cocks:
 - .1 Balancing service where shut-off or isolating valve is also provided.

- .9 Drain Valves:
 - .1 Near main shut-off valves.
 - .2 Low points in piping systems.
 - .3 Bases or vertical risers.
 - .4 At equipment.

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Not used.
- 1.2 REFERENCES .1 All reference documents are the latest edition.
- .2 American Society of Mechanical Engineers (ASME)
.1 ASME B31.1, Power Piping.
- .3 ASTM International
.1 ASTM A 125, Standard Specification for Steel Springs, Helical, Heat-Treated.
.2 ASTM A 307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
.3 ASTM A 563, 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, Pipe Hangers and Supports - Materials, Design and Manufacture.
.2 MSS SP 69, Pipe Hangers and Supports - Selection and Application.
.3 MSS SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 Underwriter's Laboratories of Canada (ULC)
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario.
.2 Submit shop drawings and product data for following items:
.1 Bases, hangers and supports.
.2 Connections to equipment and structure.
.3 Structural assemblies.
.4 Quality Assurance Submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
.1 Certification by manufacturer: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
.2 Instructions: submit manufacturers installation instruction.
.1 Departmental Representative will make available one (1) copy of systems suppliers installation instructions.
- 1.4 CLOSEOUT SUBMITTALS .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING	.1	Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
	.2	Delivery and Acceptance Requirements: .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
PART 2 - PRODUCTS		
2.1 SYSTEM DESCRIPTION	.1	Design Requirements: .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies. .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58. .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure. .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment. .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP 58.
2.2 SUSTAINABLE REQUIREMENTS	.1	Not used.
2.3 GENERAL	.1	Fabricate hangers, supports and sway braces in accordance with MSS SP 58. ANSI B31.1 and SMACNA.
	.2	Use components for intended design purpose only. Do not use for rigging or erection purposes.
2.4 PIPE HANGERS	.1	Finishes: .1 Pipe hangers and supports: galvanized or painted with zinc-rich paint after manufacture. .2 Use electro-plating galvanizing process or hot dipped galvanizing process. .3 Ensure steel hangers in contact with copper piping are epoxy coated.
	.2	Upper attachment structural: suspension from lower flange of I-Beam: .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip. .1 Rod: 13 mm. .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers.
	.3	Upper attachment structural: suspension from upper flange of I-Beam: .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with

hardened steel cup point setscrew, locknut and carbon steel retaining clip.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer.

.4 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate to MSS SP 69.

.5 Shop and field-fabricated assemblies:

.1 Trapeze hanger assemblies: MSS SP89.

.2 Steel brackets: MSS SP89.

.3 Sway braces for seismic restraint system: to MSS SP89.0.

.6 Hanger rods: threaded rod material to MSS SP 58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.7 Pipe attachments: material to MSS SP 58:

.1 Attachments for steel piping: carbon steel.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports to accept thermal expansion and pipe insulation.

.8 Adjustable clevis: material to MSS SP 69 ULC listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 69.

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

.1 Finishes for steel pipework: black or galvanized.

.2 Finishes for copper, glass, brass or aluminum pipework: black or galvanized, with formed portion plastic coated or epoxy coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 69.

2.5 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed, FM approved where required.

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.6 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

	.1	64 kg/m ³ density insulation plus insulation protection shield to: MSS SP 69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
	.2	Insulated hot piping: .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP 69.
2.7 CONSTANT SUPPORT SPRING HANGERS	.1	Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/- 5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
	.2	Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
	.3	Provide upper and lower factory set travel stops.
	.4	Provide load adjustment scale for field adjustments.
	.5	Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
	.6	Individually calibrated scales on each
2.8 VARIABLE SUPPORT SPRING HANGERS	.1	Vertical movement: 13 mm minimum, 50 mm maximum, use single spring precompressed variable spring hangers.
	.2	Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
	.3	Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
	.4	Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/- 5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.
2.9 EQUIPMENT SUPPORTS	.1	Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel. Submit structural calculations with shop drawing stamped by a Professional Engineer certified to do work in Ontario.
2.10 EQUIPMENT ANCHOR BOLTS AND TEMPLATES	.1	Provide templates to ensure accurate location of anchor bolts.
2.11 HOUSE-KEEPING PADS	.1	For base mounted equipment: Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges, 25mm.

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 INSTALLATION .1 Install in accordance with:
.1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
.1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
.2 Bolt-tightening torques to industry standards.
.3 Steel pipes: install below coupling or shear lugs welded to pipe.
.4 Cast iron pipes: install below joint.
- .4 Clevis plates:
.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
.1 Vertical movement of pipework is 13 mm or more.
.2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
.1 Transfer of load to adjacent piping or to connected equipment is not critical.
.2 Variation in supporting effect does not exceed 25% of total load.
- 3.3 HANGER SPACING .1 Plumbing piping: to National Building Code.
- .2 Not used.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size: NPS	Maximum Spacing: Steel (m)	Maximum Spacing: Copper (m)
Up to 1-1/4	2.1	1.8
1-1/2	2.7	2.4
2	3.0	2.7
2-1/2	3.6	3.0
3	3.6	3.0
3-1/2	3.7	3.3
4	4.2	3.6
5	4.8	--
6	5.1	--
8	5.7	--
10	6.6	--
12	6.9	--
Pipework greater than NPS 12: to MSS SP69		

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

3.7 FIELD QUALITY CONTROL

- .1 Not used.

3.8 CLEANING

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

PART 1 - GENERAL

- 1.1 SUMMARY .1 Not used.
- 1.2 REFERENCES .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 Canadian Gas Association (CGA)
.1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
- .3 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
.2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
.1 NFPA 13, Standard for the Installation of Sprinkler Systems.
.2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Product Data:
.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
.2 Product data to include paint colour chips, other products specified in this section.
.3 Samples:
.1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
.2 Samples to include nameplates, labels, tags, lists of proposed legends.
- 1.4 QUALITY ASSURANCE .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- 1.5 DELIVERY, STORAGE, AND HANDLING .1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

PART 2 - PRODUCTS

- 2.1 SUSTAINABLE REQUIREMENTS .1 Not used.
- 2.2 MANUFACTURER'S EQUIPMENT .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

NAMEPLATES

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

2.3 SYSTEM
NAMEPLATES

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

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20
 - .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use #5.
 - .2 Equipment in Mechanical Rooms: use #9.

2.4 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.

2.5 PIPING SYSTEMS
GOVERNED BY CODES

- .1 Identification:
 - .1 Natural gas: to CSA/CGA B149.1.
 - .2 Propane gas: to CSA/CGA B149.1.
 - .3 Sprinklers: to NFPA 13.
 - .4 Standpipe and hose systems: to NFPA 14.
 - .5 Medical Gas: to CAN/CSA Z 7396.1.

2.6 IDENTIFICATION
OF PIPING SYSTEMS

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

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

Background Colour:	Legend Arrows
Yellow	BLACK
Green	WHITE
Red	WHITE

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

Contents	Background Colour Marking	Legend
Raw water	Green	RAW WATER
River water	Green	RIVER WATER
Sea water	Green	SEA WATER
City water	Green	CITY WATER
Treated water	Green	TREATED WATER
Brine	Green	BRINE
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
High temp HW Htg. Supply	Yellow	HTHW HTG. SUPPLY++
High temp HW Htg. Return	Yellow	HTHW HTG. RETURN++

Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED WTR
Steam _____ kPa	Yellow	_____ kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Continuous blow-off	Yellow	CONT. BLOW-OFF
Chilled drinking water	Green	CH. DRINK WTR
Drinking water return	Green	CH. DRINK WTR. CIRC
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Contaminated lab waste	Yellow	CONT. LAB WASTE
Acid waste	Yellow	ACID WASTE (add source)
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
No. _____ fuel oil suction	Yellow	# _____ FUEL OIL
No. _____ fuel oil return	Yellow	# _____ FUEL OIL
Engine exhaust	Yellow	ENGINE EXHAUST
Lubricating oil	Yellow	LUB. OIL
Hydraulic oil	Yellow	HYDRAULIC OIL
Gasoline	Yellow	GASOLINE
Natural gas	to Codes	
Propane	to Codes	
Gas regulator vents	to Codes	
Distilled water	Green	DISTILL. WTR
Demineralized water	Green	DEMIN. WATER
Chlorine	Yellow	CHLORINE
Nitrogen	Yellow	NITROGEN
Oxygen	Yellow	OXYGEN
Compressed air (<700kPa)	Green	COMP. AIR _____ kPa
Compressed air (>700kPa)	Yellow	COMP. AIR _____ kPa
Vacuum	Green	VACUUM
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS
Carbon dioxide	Red	CO2
Instrument air	Green	INSTRUMENT AIR

- 2.7 IDENTIFICATION .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- DUCTWORK SYSTEMS .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.
- .3 Identify Systems: eg Supply AHU-1, Exhaust EF-1
- 2.8 VALVES, .1 Brass tags with 12 mm stamped identification data filled with black paint.
- CONTROLLERS

2.9 CONTROLS COMPONENTS IDENTIFICATION	.1	Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
	.2	Inscriptions to include function and (where appropriate) fail-safe position.
2.10 LANGUAGE	.1	Identification in English.
PART 3 - EXECUTION		
3.1 MANUFACTURER'S INSTRUCTIONS	.1	Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
3.2 TIMING	.1	Provide identification when subsequent work will not adversely affect the identification.
3.3 INSTALLATION	.1	Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
	.2	Provide ULC or CSA registration plates as required by respective agency.
3.4 NAMEPLATES	.1	Locations: .1 In conspicuous location to facilitate easy reading and identification from operating floor.
	.2	Standoffs: .1 Provide for nameplates on hot and/or insulated surfaces.
	.3	Protection: .1 Do not paint, insulate or cover.
	.1	On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
	.2	Adjacent to each change in direction.
	.3	At least once in each small room through which piping or ductwork passes.
3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS	.4	On both sides of visual obstruction or where run is difficult to follow.
	.5	On both sides of separations such as walls, floors, partitions.
	.6	Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

	.7	At beginning and end points of each run and at each piece of equipment in run.
	.8	At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
	.9	Identification easily and accurately readable from usual operating areas and from access points.
	.1	Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.
3.6 VALVES, CONTROLLERS	.1	Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
	.2	Not used.
	.3	Number valves in each system consecutively.
3.7 FIELD QUALITY CONTROL	.1	Not used.
3.8 CLEANING	.1	Proceed in accordance with Section 01 74 11 - Cleaning.
	.2	Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

- 1.1 SUMMARY
- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
 - .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.
- 1.2 QUALIFICATIONS OF TAB PERSONNEL
- .1 Submit names of personnel to perform TAB to Departmental Representative within 14 calendar days of award of contract.
 - .2 Provide documentation confirming qualifications, successful experience.
 - .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - 1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.
 - .2 National Balancing Council (NBC) Certified Air Balancing Specifications and Certified Hydronic Balancing Specifications.
 - .3 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
 - .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
 - .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
 - .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
 - .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
 - .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.
- 1.3 PURPOSE OF TAB
- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
 - .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions. (Cont'd)

- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.
- 1.4 EXCEPTIONS
 - .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.
- 1.5 CO-ORDINATION
 - .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
 - .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.
- 1.6 PRE-TAB REVIEW
 - .1 Review contract documents before project construction is started and confirm in writing to Consultant and Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
 - .2 Review specified standards and report to Consultant and Departmental Representative in writing proposed procedures which vary from standard.
 - .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.
- 1.7 START-UP
 - .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
 - .2 Follow special start-up procedures specified elsewhere in Division 23.
- 1.8 OPERATION OF SYSTEMS DURING TAB
 - .1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.
- 1.9 START OF TAB
 - .1 Notify Departmental Representative and Consultant 7 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 weatherstripping, 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 Correct fan rotation.

		.5	Fire, smoke, volume control dampers installed and open.
		.6	Coil fins combed, clean.
		.7	Access doors, installed, closed.
		.8	Outlets installed, volume control dampers open.
	.3	Liquid systems:	
		.1	Flushed, filled, vented.
		.2	Correct pump rotation.
		.3	Strainers in place, baskets clean.
		.4	Isolating and balancing valves installed, open.
		.5	Calibrated balancing valves installed, at factory settings.
		.6	Chemical treatment systems complete, operational.
1.10 APPLICATION TOLERANCES	.1	Do TAB to following tolerances of design values:	
		.1	HVAC systems: plus 5 %, minus 5 %.
		.2	Hydronic systems: plus or minus 10 %.
1.11 ACCURACY TOLERANCES	.1	Measured values accurate to within plus or minus 2 % of actual values.	
1.12 INSTRUMENTS	.1	Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.	
	.2	Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.	
	.3	Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.	
1.13 ACTION AND INFORMATIONAL SUBMITTALS	.1	Submit, prior to commencement of TAB:	
		.1	Proposed methodology and procedures for performing TAB if different from referenced standard.
1.14 PRELIMINARY TAB REPORT	.1	Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:	
		.1	Details of instruments used.
		.2	Details of TAB procedures employed.
		.3	Calculations procedures.
		.4	Summaries.
1.15 TAB REPORT	.1	Format in accordance with TAB Firm's general format.	
	.2	TAB report to show results in SI units and to include:	
		.1	Project record drawings.
		.2	System schematics.
	.3	Submit TAB Report to Consultant and Departmental Representative for verification and approval, in English in D-ring binders and an electronic drive, complete with index tabs.	

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| 1.16 VERIFICATION | .1 | Reported results subject to verification by Consultant and CSC Representative. |
| | .2 | Provide personnel and instrumentation to verify up to 30 % of reported results. |
| | .3 | Number and location of verified results as directed Consultant and CSC Representative. |
| | .4 | Pay costs to repeat TAB as required to satisfaction of CSC Representative. |
| 1.17 SETTINGS | | |
| | .1 | After TAB is completed to satisfaction of CSC Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings. |
| | .2 | Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings. |
| 1.18 COMPLETION OF TAB | | |
| | .1 | TAB considered complete when final TAB Report received and approved by CSC Representative. |
| 1.19 AIR SYSTEMS | | |
| | .1 | Standard: TAB to most stringent of this section or TAB standards of SMACNA and ASHRAE. |
| | .2 | Do TAB of following systems, equipment, components, controls: |
| | .1 | ERV-1 & ERV-2. |
| | .3 | Qualifications: personnel performing TAB qualified to standards of AABC or NEBB. |
| | .4 | Quality assurance: perform TAB under direction of supervisor qualified [] [to standards of] [AABC] [or] [NEBB]. |
| | .5 | Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration. |
| | .6 | Locations of equipment measurements: to include as appropriate: |
| | .1 | Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions. |
| | .2 | At controllers, controlled device. |
| | .7 | Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser). |
| 1.20 OTHER TAB REQUIREMENTS | | |
| | .1 | Chemical treatment systems: |
| | .1 | Standard: Section 23 25 00 - HVAC Water Treatment Systems. |
| | .2 | TAB procedures: refer to Section 23 25 00 - HVAC Water Treatment Systems. |

PART 2 - PRODUCTS

2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

PART 1 - GENERAL

- 1.1 SUMMARY
- .1 Related Requirements
- .1 Not used.
- 1.2 REFERENCES
- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .1 ASHRAE Standard 90.1-13, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .3 American Society for Testing and Materials (ASTM International)
- .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449/C449M, Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C533, Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- .6 ASTM C547, Specification for Mineral Fiber Pipe Insulation.
- .7 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .8 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
- .9 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .10 ASTM C921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .4 Canadian General Standards Board (CGSB)
- .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .5 Thermal Insulation Association of Canada (TIAC)
- .1 National Insulation Standards.
- .6 National Energy Code of Canada for Buildings (NECB).
- .7 Underwriters' Laboratories of Canada (ULC)
- .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

1.3 DEFINITIONS	.1	For purposes of this section: .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces. .2 "EXPOSED" - will mean "not concealed" as specified.
	.2	TIAC ss: .1 CRF: Code Rectangular Finish. .2 CPF: Code Piping Finish.
1.4 ACTION AND INFORMATIONAL SUBMITTALS	.1	Not used.
1.5 QUALITY ASSURANCE	.1	Qualifications: .1 Installer: specialist in performing work of this Section, successful experience in this size and type of project, qualified to standards of TIAC.
1.6 DELIVERY, STORAGE AND HANDLING	.1	Packing, shipping, handling and unloading: .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements. .2 Deliver, store and handle materials in accordance with manufacturer's written instructions. .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
	.2	Storage and Protection: .1 Protect from weather, construction traffic. .2 Protect against damage. .3 Store at temperatures and conditions required by manufacturer.
PART 2 - PRODUCTS		
2.1 SUSTAINABLE REQUIREMENTS	.1	Not used.
2.2 FIRE AND SMOKE RATING	.1	In accordance with CAN/ULC-S102. .1 Maximum flame spread rating: 25. .2 Maximum smoke developed rating: 50.
2.3 INSULATION	.1	Mineral fibre specified includes glass fibre, rock wool, slag wool.
	.2	Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.

- .3 TIAC Code A-1: Rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C547.
 - .2 Maximum "k" factor: ASTM C547.
- .4 TIAC Code A-3: Rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C547.
 - .2 Jacket: to CGSB 1-GP-52Ma.
 - .3 Maximum "k" factor: ASTM C547.
- .5 TIAC Code C-1: Rigid mineral fibre board, unfaced.
 - .1 Mineral fibre: ASTM C612.
 - .2 Maximum "k" factor: ASTM C612.
- .6 TIAC Code C-4: Rigid mineral fibre board faced with factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C612.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: ASTM C612.
- .7 TIAC Code C-2: Mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: ASTM C553.
- .8 TIAC Code A.6: Flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor.
 - .4 Certified by manufacturer free of potential stress corrosion cracking corrodants.
- .9 TIAC Code A-2: Rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: ASTM C533.
 - .2 Maximum "k" factor: ASTM C533.
 - .3 Design to permit periodic removal and re-installation.

2.4 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, reinforced 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation.
- .7 Fasteners: 2 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

- 2.5 CEMENT .1 Thermal insulating and finishing cement:
.1 Hydraulic setting or Air drying on mineral wool, to ASTM C 449/C 449M.
- 2.6 VAPOUR RETARDER .1 Water based, fire retardant type, compatible with insulation.
LAP ADHESIVE
- 2.7 INDOOR VAPOUR .1 Vinyl emulsion type acrylic, compatible with insulation.
RETARDER FINISH
- 2.8 OUTDOOR VAPOUR .1 Vinyl emulsion type acrylic, compatible with insulation.
RETARDER FINISH
.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- 2.9 JACKETS .1 Polyvinyl Chloride (PVC):
.1 One-piece moulded type to CAN/CGSB-51.53 with pre-formed shapes as required.
.2 Colours: white.
.3 Minimum service temperatures: -20 degrees C.
.4 Maximum service temperature: 65 degrees C.
.5 Moisture vapour transmission: 0.02 perm.
.6 Thickness: 0.8 mm.
.7 Fastenings:
.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
.2 Tacks.
.3 Pressure sensitive vinyl tape of matching colour.
.8 Special requirements:
.1 Indoor: Flame spread rating 25, smoke developed 50.
.2 Outdoor: UV rated material at least 0.5 mm thick.
- .2 ABS Plastic:
.1 One-piece moulded type and sheet with pre-formed shapes as required.
.2 Colours: to match adjacent finish paint.
.3 Minimum service temperatures: -40°C.
.4 Maximum service temperature: 82°C.
.5 Moisture vapour transmission: 0.012 perm.
.6 Thickness: 0.75 mm.
.7 Fastenings:
.1 Solvent weld adhesive compatible with insulation to seal laps and joints
.2 Tacks.
.3 Pressure sensitive vinyl tape of matching colour.
.8 Locations:
.1 For outdoor use ONLY.
- .3 Canvas:
.1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
.2 Lagging adhesive: compatible with insulation.

2.10 REMOVABLE
INSULATION COVERS

- .4 Aluminum:
 - .1 To ASTM B 209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: smooth or stucco embossed.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.
- .1 General:
 - .1 All Covers shall be sewn, stapled or "hog-ringed" covers shall not be acceptable.
 - .2 Covers shall conform to the configuration of the items being insulated.
 - .3 Covers shall include openings for all protrusions such as pipes, packing glands on valves and expansion joints, hangers, supports, instrument lines, and other appurtenances.
 - .4 Covers shall be designed so that no force bending or folding of the cover is necessary for installation.
 - .5 Minimum 50 mm wide flaps at terminal ends are to be provided to overlap adjacent covers to ensure a good heat seal.
 - .6 Parting seems shall be at the installed low points (gravitational bottom) of the cover to allow drainage without the use of weep tubes or grommets.
 - .7 Valve bonnets are to be covered, but packing glands shall remain exposed.
 - .8 Valve covers are to be designed such that the bonnet section is sewn to the body section. For larger valves, the cover may be fabricated in two sections, each section containing one half of the valve body bonnet.
 - .9 Covers with a weight of 18.1 Kg or less are to be fabricated in one piece.
 - .10 Covers with a weight of more than 18.1 Kg are to be fabricated in more than one piece.
- .2 Insulation Core:
 - .1 The insulation core shall be fabricated in one piece, wherever possible.
 - .2 To prevent insulation settlement, the insulation core shall be secured within the jacket through the weather barrier (outer jacketing), the insulation, and the liner (inner jacketing).
 - .3 Insulating cores with more than one piece shall have staggered joints to prevent hot spots and heat loss. The joint edges shall be butted together and extra securement provided at those edges.
 - .4 Insulation core shall be comprised of 50 mm thick fiberglass insulation of noncombustible wool with resilient inorganic glass fibers bonded with a thermosetting resin. Insulation density to be 38 Kg/m³. Insulation thermal conductivity to be 0.044W/m. deg C at a mean temperature of 100 deg C.
- .3 Jacket:
 - .1 The jacket shall be fabricated in one piece, wherever possible.
 - .2 Gusset walls shall be required for covers with core insulation thickness in excess of 25 mm.
 - .3 All seams, except the final closing seam, shall be inside seams. The jackets are to be sewn inside out, then turned correct side out before inserting the insulation core. The final closing seam shall be sewn on the exterior of the jacket. Seams shall be sewn with Teflon coated fiberglass thread or Kevlar coated stainless steel thread.

2.11 WEATHERPROOF
CAULKING FOR
JACKETS INSTALLED
OUTDOORS

PART 3 - EXECUTION

3.1 MANUFACTURER'S
INSTRUCTIONS

3.2
PRE-INSTALLATION
REQUIREMENT

- .4 Machine stitching shall be used for all sewing. Sewing shall be 6-8 stitches per centimeter.
- .5 Draw cords are to be placed along the outer edge of the flap and the outer edge of the flap then rolled back inside and double stitched.
- .6 Draw cords are to be of sufficient length to allow 150 mm of cords to protrude from each side of the flap.
- .7 The inner and outer jacket shall be comprised of a fiberglass fabric impregnated with silicone rubber. The silicone rubber shall be flame retardant and suitable for high temperature usage. Outer jacket density shall be 595 gms/m².
- .4 Securement devices:
 - .1 The securement belts and D-ring belts shall be of the same material as the weather barrier (exterior jacket).
 - .2 The belts shall be placed 50 mm back from the parting seams and on 150 mm centers.
 - .3 Fire retardant Velcro shall be used to fasten the securement belt to the weather barrier after the belt passed through the Stainless Steel D-rings.
- .5 Identification tags:
 - .1 Each cover shall be identified by a permanently attached stainless steel tag.
 - .2 An identification legend shall be mechanically embossed into the tag.
 - .3 The tags shall be located in the same areas on similar type covers.
 - .4 Should a cover require more than one piece for its construction, each piece to be identified and numbered (i.e. 1 or 3)
 - .5 Each tag shall include at least the following information, but may also include any pertinent information required by the end user.
 - .1 Type of item being covered.
 - .2 Location of item.
 - .3 Recording and tracking information.
- .6 Warranty:
 - .1 Provide a 5-year product Warranty.

- .1 Not used.

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

- 3.3 INSTALLATION
- .1 Install in accordance with TIAC National Standards.
 - .2 Apply materials in accordance with manufacturers instructions and this specification.
 - .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
 - .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
 - .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- 3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES
- .1 Application:
 - .1 Domestic water service entrance backflow preventer.
 - .2 Domestic water service entrance pressure reducing valve assembly.
 - .3 Domestic water service entrance O.S. & Y gate valve.
 - .4 Domestic water service entrance copper connection butterfly valves NPS 2 ½ and larger.
 - .5 Domestic water service entrance wye - strainer.
 - .6 Domestic hot water service pump assemblies.
 - .7 Steam and condensate system pump assemblies; - pumps, suction diffusers, triple duty valves.
 - .8 Steam and condensate system valves NPS 2 1/2 and larger -gate, globe and butterfly.
 - .9 Steam and condensate system flex connections, expansion joints.
 - .10 Balancing valves NPS 2 1/2 and above.
 - .11 Two-Way Control valves NPS 2 1/2 and larger.
 - .12 Three-Way Control valves NPS 2 1/2 and larger.
 - .13 Expansion joints.
 - .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
 - .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: same as system.
- 3.5 INSTALLATION OF ELASTOMERIC INSULATION
- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
 - .2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: SS wire or bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Securements: SS wire or bands at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp deg C	TIAC Code	Pipe sizes (NPS) and insulation thickness (mm)			
			<1	1 to <1- 1/2	1-1/2 to <4	4 to <9
Steam	up to 175	A-1	38	38	50	50
Condensate Return	60-94	A-1	38	38	50	50
Pumped Condensate Return	up to 94	A-1	38	38	50	50
Hot Water Heating	60-94	A-1	38	38	50	50
Glycol Heating	60-94	A-1	38	38	50	50
Domestic CWS		A-3	13	13	13	13
Domestic HWS		A-1	38	38	50	50

- .5 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Exposed in mechanical rooms: PVC jacket.
 - .3 Concealed, indoors: canvas on piping, valves, and fittings.
 - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .5 Within 300 mm of boiler: canvas on piping, valves, and fittings.
 - .6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 FIELD QUALITY CONTROL

- .1 Not used.

3.8 CLEANING

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

PART 1 - GENERAL

- | | | |
|--|----|--|
| 1.1 RELATED REQUIREMENTS | .1 | Not used. |
| 1.2 REFERENCES | .1 | The latest revisions of the following standards shall apply unless noted otherwise. |
| | .2 | American Society for Testing and Materials International (ASTM) |
| | .1 | ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols. |
| 1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS | .1 | In accordance with Section [23 08 02 - Cleaning and Start-up of Mechanical Piping Systems]. |
| 1.8 STEAM SYSTEMS | .1 | Performance verification: |
| | .1 | When systems are operational, perform relevant tests of steam and condensate return piping 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. |
| 1.9 GASEOUS FUEL SYSTEMS | .1 | Operation tests: |
| | .1 | Measure gas pressure at gas meter outlet and at burner manifold. |

- .2 Verify details of temperature and pressure compensation at meter.
- .3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.
- .4 Check terminals of vents for gas pressure regulators.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

- | | | |
|---|----|--|
| 1.1 SUMMARY | .1 | Related Requirements |
| | .1 | Not used. |
| 1.2 REFERENCES | .1 | American Society for Testing and Materials International (ASTM) |
| | .1 | ASTM E 202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols. |
| | .2 | Health Canada/Workplace Hazardous Materials Information System (WHMIS) |
| | .1 | Material Safety Data Sheets (MSDS). |
| 1.3 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 | Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures. |
| | .1 | Instructions: submit manufacturer's installation instructions. |
| 1.4 QUALITY ASSURANCE | .1 | Health and Safety: |
| | .1 | Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health, Safety and Emergency Response Procedures. |
| 1.5 DELIVERY, STORAGE, AND HANDLING | .1 | Packing, shipping, handling and unloading: |
| | .1 | Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements. |
| | .2 | Waste Management and Disposal: |
| | .1 | Construction/Demolition Waste Management and Disposal: separate waste materials for reuse in accordance with Section 01 74 00 - Cleaning and Waste Management. |

PART 2 - PRODUCTS

- | | | |
|------------------------------|----|---|
| 2.1 SUSTAINABLE REQUIREMENTS | .1 | Not used. |
| 2.2 CLEANING SOLUTIONS | .1 | Low-foaming detergent: at all temperatures. |
| | .2 | Designed for use on most metals including aluminum. |
| | .3 | No pH neutralization required. |

- .4 Phosphate free.
- .5 Biodegradable.
- .6 Nitrate Free.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Steam Systems: in addition to general requirements as specified above, perform following:
 - .1 Remove internal components of steam traps until flushing and warm-up have been completed.
 - .2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.
 - .3 Starting at drip point closest to source, verify removal of condensate, then

reinstall steam trap internal parts. Repeat sequence down the line.

.4 Water hammer: determine source and eliminate cause.

.8 Steam boilers:

.1 Isolate boilers from piping system.

.2 Fill to normal operating level. Add cleaner. Fire to 50% of design operating steam pressure. Maintain for 24 h, during which blow down boiler every 4 h including water columns, controls, skimmer lines and valves, test cocks, blow down valves. Add water to return to operating level.

.3 Allow boiler to cool, then drain, flush and inspect.

.4 Reconnect to piping system.

.5 Refill boiler with clean softened water and immediately add chemical inhibitors.

.6 Apply heat slowly and raise to normal design operating steam pressure. Maintain for 4 h.

.7 Discharge condensate from steam system to sewer for 96 h after initial operation. During this period continue chemical treatment of boilers with inhibitors to ensure complete removal of oils, grease and millscale from steam and condensate return piping steam.

.8 Drain steam condensate until it is clean and free from suspended matter. Ensure proper operation of steam traps.

.9 Allow boiler to cool, drain, open inspection ports and wash out with clean water.

.10 If boiler is not used immediately, refill with softened water, add sodium sulphite, bring up to pressure. Test for residual sulphite.

.11 After cleaning is completed and system is filled, perform relevant start-up procedures as specified for hydronic systems:

3.3 CLEANING

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

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

Section 23 09 23
Instrumentation and Control for HVAC

CSC Headquarters

Prepared By:
Greer Galloway

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23 09 23 Direct-Digital Control System for HVAC
PART 1: GENERAL

- 1.1 Section Includes**
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- 1.10 System Performance**
- 1.11 Submittals**
- 1.12 Warranty**
- 1.13 Ownership of Proprietary Material**
- 1.14 Definitions**

1.1 Products Furnished but Not Installed under This Section**A. Section 23 09 13.33 - Control Valves**

1. Control valves

1.2 Products Installed but Not Furnished under This Section**A. None****1.3 Products Not Furnished or Installed under but Integrated with the Work of This Section****A. Section - General**

1. Coordination Meeting: The Installer furnishing the DDC network shall meet with the Installer(s) furnishing each of the following products to coordinate details of the interface between these products and the DDC network. The Owner or his designated representative shall be present at this meeting. Each Installer shall provide the Owner and all other Installers with details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, and required network accessories. The purpose of this meeting shall be to insure there are no unresolved issues regarding the integration of these products into the DDC network. Submittals for these products shall not be approved prior to the completion of this meeting.

B. Section 23 52 00 - Heating Boilers

1. Boiler controls: The boiler vendor shall furnish boilers with an interface to the control and monitoring points specified in Section 23 09 93. These specified points shall be the minimum acceptable interface to the boiler. The connection to these points shall be by BACnet/IP network connection or BACnet MS/TP network connection based on existing system architecture.

1.4 Description

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers connected to the existing building system.
- B. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. I/O points, schedules, setpoints, trends and alarms specified in 23 09 93 – “Sequence of Operations for HVAC Controls” shall be BACnet objects.

1.5 Approved Control system Manufacturers

- A. The following are approved control system suppliers, manufacturers, and product lines:

Supplier	Manufacturer	Product Line
Taughner Controls	Delta Controls	

The above list does not indicate order of preference. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification.

1. The Contractor shall use only operator workstation software, controller software, custom application programming language, and controllers from the corresponding manufacturer and product line unless Owner approves use of multiple manufacturers.
2. Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.6 Quality Assurance

A. Installer and Manufacturer Qualifications

1. Installer shall have an established working relationship with Control System Manufacturer.
2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

1.7 Codes and Standards

- ### **A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:**
1. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.8 System Performance

- ### **A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).**
1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.

5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

Table-1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	$\pm 0.5^{\circ}\text{C}$ ($\pm 1^{\circ}\text{F}$)
Ducted Air	$\pm 0.5^{\circ}\text{C}$ ($\pm 1^{\circ}\text{F}$)
Outside Air	$\pm 1.0^{\circ}\text{C}$ ($\pm 2^{\circ}\text{F}$)
Dew Point	$\pm 1.5^{\circ}\text{C}$ ($\pm 3^{\circ}\text{F}$)
Water Temperature	$\pm 0.5^{\circ}\text{C}$ ($\pm 1^{\circ}\text{F}$)
Delta-T	$\pm 0.15^{\circ}$ ($\pm 0.25^{\circ}\text{F}$)
Relative Humidity	$\pm 5\%$ RH
Water Flow	$\pm 2\%$ of full scale
Airflow (terminal)	$\pm 10\%$ of full scale (see Note 1)
Airflow (measuring stations)	$\pm 5\%$ of full scale
Airflow (pressurized spaces)	$\pm 3\%$ of full scale
Air Pressure (ducts)	± 25 Pa (± 0.1 in. w.g.)
Air Pressure (space)	± 3 Pa (± 0.01 in. w.g.)
Water Pressure	$\pm 2\%$ of full scale (see Note 2)
Electrical	$\pm 1\%$ of reading (see Note 3)
Carbon Monoxide (CO)	$\pm 5\%$ of reading
Carbon Dioxide (CO ₂)	± 50 ppm

Note 1: Accuracy applies to 10%–100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	± 50 Pa (± 0.2 in. w.g.) ± 3 Pa (± 0.01 in. w.g.)	0–1.5 kPa (0–6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	$\pm 10\%$ of full scale	
Space Temperature	$\pm 1.0^{\circ}\text{C}$ ($\pm 2.0^{\circ}\text{F}$)	
Duct Temperature	$\pm 1.5^{\circ}\text{C}$ ($\pm 3^{\circ}\text{F}$)	
Humidity	$\pm 5\%$ RH	
Fluid Pressure	± 10 kPa (± 1.5 psi) ± 250 Pa (± 1.0 in. w.g.)	MPa (1–150 psi) 0–12.5 kPa (0–50 in. w.g.) differential

1.9 Submittals

- A. Product Data and Shop Drawings: Meet requirements of Section 01 30 00 on Shop Drawings, Product Data, and Samples. In addition, the contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and PDF format. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided with sufficient time to allow for substantial completion in compliance with the owner's requirements. Submittals shall include:

1. DDC System Hardware

- a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
- b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 - i. Direct digital controllers (controller panels)
 - ii. Transducers and transmitters
 - iii. Sensors (including accuracy data)
 - iv. Actuators
 - v. Valves
 - vi. Relays and switches
 - vii. Control panels
 - viii. Power supplies
 - ix. Batteries
 - x. Operator interface equipment
 - xi. Wiring
- c. Wiring diagrams and layouts for each control panel. Show termination numbers.
- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.

2. Central System Hardware and Software

- a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.

- b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 - i. Central Processing Unit (CPU) or web server
 - ii. Monitors
 - iii. Keyboards
 - iv. Power supplies
 - v. Battery backups
 - vi. Interface equipment between CPU or server and control panels
 - vii. Operating System software
 - viii. Operator interface software
 - ix. Color graphic software
 - x. Third-party software
 - c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.
 - 3. Controlled Systems
 - a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List I/O points and software points specified in Section 23 09 93. Indicate alarmed and trended points.
 - 4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.

5. A description of the proposed process along with all report formats and checklists to be used in Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).
6. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

B. Schedules

1. Within one month of contract award, provide a schedule of the work indicating the following:
 - a. Intended sequence of work items
 - b. Start date of each work item
 - c. Duration of each work item
 - d. Planned delivery dates for ordered material and equipment and expected lead times
 - e. Milestones indicating possible restraints on work by other trades or situations
2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

C. Project Record Documents. Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:

1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD compatible files on magnetic or optical media (file format: .DWG, .DXF, .VSD, or comparable) and in PDF format.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).
3. Operation and Maintenance (O&M) Manual.
4. As-built versions of submittal product data.
5. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
7. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
8. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
9. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.

10. Graphic files, programs, and database on magnetic or optical media.
 11. List of recommended spare parts with part numbers and suppliers.
 12. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 13. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 14. Licenses, guarantees, and warranty documents for equipment and systems.
 15. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- D. Training Materials: Contractor to provide training for relevant O&M staff.

1.10 Warranty

A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
5. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.11 Ownership of Proprietary Material

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
1. Graphics
 2. Record drawings
 3. Database
 4. Application programming code
 5. Documentation

1.12 Definitions

Term	Definition
BACnet Interoperability Building Blocks (BIBB)	A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.
Wiring	Raceway, fittings, wire, boxes and related items.

PART 2: PRODUCTS

- 2.1 Section Includes**
- 2.2 Materials**
- 2.3 Communication**
- 2.4 Operator Interface**
- 2.5 Controller Software**
- 2.6 Controllers**
- 2.7 Input and Output Interfaces**
- 2.8 Power Supplies and Line Filtering**
- 2.9 Auxiliary Control Devices**
- 2.10 Wiring and Raceways**
- 2.11 Fiber Optic Cable System**
- 2.12 Compressed Air Supply - Pneumatic**

2.1 Materials

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 Communication

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 23 09 93. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.3 Operator Interface

- A. Operator Interface. Utilize existing system.

- B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol.
- C. Hardware.
 - 1. Workstation or web server. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:
 - a. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
- D. System Software.
 - 1. Operating System. Utilize existing system.
 - 2. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract.
 - a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in or shall only require widely available no-cost plug-ins (such as Adobe Flash).
 - 3. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in the same formats as are used for system graphics.
 - 4. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard

symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

E. System Applications.

1. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
2. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 (Sequences of Operation). Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
3. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
4. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
5. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
6. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 (Sequences of Operation). Trends shall be BACnet trend objects.
7. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
8. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store

report data in a format accessible by standard spreadsheet and word processing programs.

9. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - i. Alarm History.
 - ii. Trend Data. Operator shall be able to select trends to be logged.
 - iii. Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

2.4 Controller Software

- A. Furnish the following applications for building and energy management. All software application shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. System Security. See Paragraph 2.3.E.5 (Security) and Paragraph 2.3.E.14.c.iii (Operator Activity).
- C. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 3. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.

- D. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- E. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
- F. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
- G. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
- H. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- I. Demand Limiting.
 - 1. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
 - 2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Section 23 09 93 (Sequences of Operation). When demand drops below adjustable levels, system shall restore loads as specified.
- J. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in 23 09 93 (Sequences of Operation).
- K. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in Section 23 09 93 (Sequences of Operation).
- L. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.

- M. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- N. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- O. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
- P. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 23 09 93 (Sequence of Operations).

2.5 Controllers

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 23 09 23 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.
- B. BACnet.
 - 1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 4. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet

Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.

5. BACnet Communication.

- a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
- b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
- c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Communication

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.

- D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - 1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
- F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.
- G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- H. Memory.
 - 1. Controller memory shall support operating system, database, and programming requirements.
 - 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 - 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 Input and Output Interface

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.

- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall allow the monitoring of low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.
- J. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system

2.7 Power Supplies and Line Filtering

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0

mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

- a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
- b. Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering.

1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.8 Auxiliary Control Devices

A. Motorized Control Dampers, unless otherwise specified elsewhere, shall be as follow.

1. Type. Control dampers shall be the parallel or opposed-blade type as specified below or as scheduled on drawings.
 - a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
 - b. Other modulating dampers shall be opposed-blade.
 - c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
2. Frame. Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.
3. Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gauge).
4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 L/s·m² (10 cfm per ft²) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).
6. Sections. Individual damper sections shall not exceed 125 cm × 150 cm (48 in. × 60 in.). Each section shall have at least one damper actuator.
7. Modulating dampers shall provide a linear flow characteristic where possible.
8. Linkages. Dampers shall have exposed linkages.

B. Electric Damper and Valve Actuators.

1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
 2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
 3. Signal and Range. Proportional actuators shall accept a 0–10 Vdc or a 0–20 mA control signal and shall have a 2–10 Vdc or 4–20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
 4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
 5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.
- C. Control Valves.
1. Control valves shall be two-way or three-way type for two-position or modulating service as shown.
 2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - i. Two-way: 150% of total system (pump) head.
 - ii. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b. Steam Valves: 150% of operating (inlet) pressure.
 3. Water Valves.
 - a. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b. Sizing Criteria:
 - i. Two-position service: Line size.
 - ii. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - iii. Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.
 - iv. Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - v. Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
 - c. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:

- i. Water zone valves—normally open preferred.
 - ii. Heating coils in air handlers—normally open.
 - iii. Chilled water control valves—normally closed.
 - iv. Other applications—as scheduled or as required by sequences of operation.
 4. Steam Valves.
 - a. Body and trim materials shall be in accordance with manufacturer's recommendations for design conditions and service with linear ports for modulating service.
 - b. Sizing Criteria:
 - i. Two-position service: pressure drop 10% to 20% of inlet psig.
 - ii. Modulating service: 100 kPa (15 psig) or less; pressure drop 80% of inlet psig.
 - iii. Modulating service: 101 to 350 kPa (16 to 50 psig); pressure drop 50% of inlet psig.
 - iv. Modulating service: over 350 kPa (50 psig); pressure drop as scheduled on plans.
- D. Binary Temperature Devices.
 1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C–30°C (55°F–85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
 2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C–30°C (55°F–85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
 3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.
- E. Temperature Sensors.
 1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
 2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross-section.
 3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.

5. Differential Sensors. Provide matched sensors for differential temperature measurement.
- F. Humidity Sensors.
 1. Duct and room sensors shall have a sensing range of 20%–80%.
 2. Duct sensors shall have a sampling chamber.
 3. Outdoor air humidity sensors shall have a sensing range of 20%–95% RH and shall be suitable for ambient conditions of -40°C–75°C (-40°F–170°F).
 4. Humidity sensors shall not drift more than 1% of full scale annually.
- G. Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
 1. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
 2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- H. Relays.
 1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
- I. Override Timers.
 1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0–6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- J. Current Transmitters.
 1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4–20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
 2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- K. Current Transformers.
 1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
 2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

L. Voltage Transmitters.

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

M. Voltage Transformers.

1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4°C–55°C (40°F–130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

N. Power Monitors.

1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
2. 1.0% full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120–600 V, and auto range select.
3. Under voltage/phase monitor circuitry.
4. NEMA 1 enclosure.
5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0–0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.

O. Hydronic Flowmeters

1. Insertion-Type Turbine Meter
 - a. Dual counter-rotating axial turbine elements, each with its own rotational sensing system, and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Single turbine for piping 2 inches and smaller. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag.
 - b. Insertion type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown.
 - c. Sensing method shall be impedance sensing (non magnetic and non photoelectric)
 - d. Volumetric accuracy
 - i. $\pm 0.5\%$ of reading at calibrated velocity
 - ii. $\pm 1\%$ of reading from 3 to 30 ft/s (10:1 range)
 - iii. $\pm 2\%$ of reading from 0.4 to 20 ft/s (50:1 range)
 - e. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% of flow rate and traceable to the National Institute of Standards and Technology (NIST).

- f. Maximum operating pressure of 400 psi and maximum operating temperature of 200°F continuous (220°F peak).
 - g. All wetted metal parts shall be constructed of 316 stainless steel.
 - h. Analog outputs shall consist of non interactive zero and span adjustments, a DC linearly of 0.1% of span, voltage output of 0-10 Vdc, and current output of 4-20 mA.
- 2. Magnetic Flow-Tube Type Flowmeter
 - a. Sensor shall be a magnetic flowmeter, which utilizes Faraday's Law to measure volumetric fluid flow through a pipe. The flowmeter shall consist of two elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
 - b. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).
 - c. Four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube. Output signal shall be a digital pulse proportional to the flow rate (to provide maximum accuracy and to handle abrupt changes in flow). Standard 4-20 mA or 0-10 Vdc outputs may be used provided accuracy is as specified.
 - d. Flow Tube:
 - i. ANSI class 150 psig steel
 - ii. ANSI flanges
 - iii. Protected with PTFE, PFA, or ETFE liner rated for 245°F minimum fluid temperature
 - e. Electrode and grounding material
 - i. 316L Stainless steel or Hastelloy C
 - ii. Electrodes shall be fused to ceramic liner and not require o-rings.
 - f. Electrical Enclosure: NEMA 4, 7
 - g. Approvals:
 - i. UL or CSA
 - ii. NSF Drinking Water approval for domestic water applications
 - h. Performance
 - i. Accuracy shall be $\pm 0.5\%$ of actual reading from 3 to 30 ft/s flow velocities, and 0.015 ft/s from 0.04 to 3 ft/s.
 - ii. Stability: 0.1% of rate over six months.
 - iii. Meter repeatability shall be $\pm 0.1\%$ of rate at velocities > 3 ft/s.
- 3. Magnetic Insertion-Type Flowmeter
 - a. Magnetic Faraday point velocity measuring device.
 - b. Insertion type complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.
 - c. 4-20 mA transmitter proportional to flow or velocity.
 - d. Accuracy: larger of 1% of reading and 0.2 ft/s.

- e. Flow range: 0.2 to 20 ft/s, bidirectional.
- f. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% of flow rate and traceable to the National Institute of Standards and Technology (NIST).
- 4. Vortex Shedding Flowmeter
 - a. Output: 4-20 mA, 0-10 Vdc, 0-5 Vdc.
 - b. Maximum Fluid Temperature: 800°F (427 °C).
 - c. Wetted Parts: Stainless Steel.
 - d. Housing: NEMA 4X.
 - e. Turndown: 25:1 minimum.
 - f. Accuracy: 0.5% of calibrated span for liquids, 1% of calibrated span for steam and gases.
 - g. Body: Wafer style or ANSI flanged to match piping specification.
- 5. Transit-Time Ultrasonic Flowmeter
 - a. Clamp-On transit-time ultrasonic flowmeter
 - b. Wide-Beam transducer technology
 - c. 4-20 mA transmitter proportional to flow or velocity.
 - d. Accuracy: 0.5% of reading in range 1 to 30 ft/s, 0.001 ft/s sensitivity.
- P. Thermal Energy Meters
 - 1. Matched RTD, solid state, or thermistor temperature sensors with a differential temperature accuracy of $\pm 0.15^{\circ}\text{F}$.
 - 2. Flow meter : See "Hydronic Flowmeters" section.
 - 3. Unit accuracy of $\pm 1\%$ factory calibrated, traceable to NIST with certification.
 - 4. NEMA 1 enclosure.
 - 5. Panel mounted display.
 - 6. UL listed.
 - 7. Isolated 4–20 ma signals for energy rate and supply and return temperatures and flow.
- Q. Current Switches.
 - 1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.
- R. Pressure Transducers.
 - 1. Transducers shall have linear output signal and field-adjustable zero and span.
 - 2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
 - 3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4–20 mA output, suitable mounting provisions, and block and bleed valves.
 - 4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa

- (300psi.) Transducer shall have 4–20 mA output, suitable mounting provisions, and 5-valve manifold.
- S. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- T. Pressure-Electric (PE) Switches.
1. Shall be metal or neoprene diaphragm actuated, operating pressure rated for 0–175 kPa (0–25 psig), with calibrated scale minimum setpoint range of 14–125 kPa (2–18 psig) minimum, UL listed.
 2. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application. Electrically rated for pilot duty service (125 VA minimum) and/or for motor control.
 3. Switches shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
 4. Each pneumatic signal line to PE switches shall have permanent indicating gauge.
- U. Occupancy Sensors. Occupancy sensors shall utilize Passive Infrared (PIR) and/or Microphonic Passive technology to detect the presence of people within a room. Sensors shall be mounted as indicated on the approved drawings. The sensor output shall be accessible by any lighting and/or HVAC controller in the system. Occupancy sensors shall be capable of being powered from the lighting or HVAC control panel, as shown on the drawings. Occupancy sensor delay shall be software adjustable through the user interface and shall not require manual adjustment at the sensor.
- V. Local Control Panels.
1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
 2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.9 Wiring and Raceways

- A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

2.10 Fiber Optic Cable System

- A. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
- B. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

PART 3: EXECUTION

- 3.1 Section Includes**
- 3.2 Examination**
- 3.3 Protection**
- 3.4 Coordination**
- 3.5 General Workmanship**
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- 3.26 Smoke Damper Installation**
- 3.27 Duct Smoke Detection**
- 3.28 Packaged Equipment Controls**
- 3.29 Start-Up and Checkout Procedures**

3.1 Examination

- A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- B. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.2 Protection

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 Coordination

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Submittals. See Section 23 09 23 Article 1.10 (Submittals).
- C. Test and Balance.
 - 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The contractor shall provide training in the use of these tools.
 - 3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 - 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- D. Life Safety.

1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in Section 23 09 93 (Sequences of Operation).
 2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in Section 23 09 93 (Sequences of Operation).
 3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.
- E. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
1. All communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
 2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation described in Section 23 09 93.
 3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
 4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.4 General Workmanship

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 Field Quality Control

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.6 Existing Equipment

- A. Wiring. Interconnecting control wiring shall be removed and shall become the property of the contractor unless specifically noted or shown to be reused.
- B. Repair. Unless otherwise directed, the contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, the engineer is to be notified immediately.
- C. Room Thermostats. Remove and deliver existing room thermostats to Owner unless otherwise noted. Patch and finish holes and marks left by removal to match existing walls.
- D. Existing System Operating Schedule. Existing mechanical system may be disabled during this work.
- E. The scheduling of fans through existing or temporary time clocks or control system shall be maintained throughout the DDC system installation
- F. Install control panels where shown.
- G. Modify existing starter control circuits, if necessary, to provide hand-off-auto control of each controlled starter. If new starters or starter control packages are required, these shall be included as part of this contract.
- H. Patch holes and finish to match existing walls.

3.7 Wiring

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-

voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- Q. Use color-coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- U. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with

couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.8 Communication Wiring

- A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- J. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - 2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - 4. An MS/TP EIA-485 network shall have no T connections.

3.9 Fiber Optic Cable

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.10 Installation of Sensors

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m²(1 ft²) of coil area.
- G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 3 m (10 ft) downstream.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- J. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - 6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

- L. Install humidity sensors for duct mounted humidifiers at least 3 m (10 ft) downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.11 Flow Switch Installation

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.12 Actuators

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
 - 1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
 - 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.
- C. Pneumatic Actuators.
 - 1. Size pneumatic damper actuator to operate the related control damper(s) with sufficient reserve power to provide smooth modulating action or two-position action. Actuator also shall be sized for proper speed of response at the velocity and pressure conditions to which the control damper is subject.
 - 2. Pneumatic damper actuators shall produce sufficient torque to close off against the maximum system pressures encountered. Size the pneumatic damper actuator to close off against the fan shutoff pressure, as a minimum.
 - 3. Where two or more pneumatic damper actuators are installed for interrelated operation in unison, such as dampers used for mixing, provide the dampers with a positive pilot positioner. The positive pilot positioner shall be directly mounted to the pneumatic damper actuator and have pressure gauges for supply input and output pressures.
 - 4. The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating. Provide at least one actuator for each damper section. Each damper actuator shall not power more than 2 m²(20 ft²) of damper.

5. Use line shafting or shaft couplings (jackshafting) in lieu of blade-to-blade linkages or shaft coupling when driving axially aligned damper sections.

3.13 Warning Labels

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
 1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
 1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

CAUTION

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.14 Identification of Hardware and Wiring

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with control system address or termination number.
- B. All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.
- F. Identify room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.15 Controllers

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with

the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in Section 23 09 93 (Sequences of Operation).

3.16 Programming

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 23 09 93 (Sequences of Operation). If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix B to Section 23 09 93 may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming.
 - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - i. Must provide actions for all possible situations
 - ii. Must be modular and structured
 - iii. Must be commented
 - b. Graphic-based:
 - i. Must provide actions for all possible situations
 - ii. Must be documented
 - c. Parameter-based:
 - i. Must provide actions for all possible situations
 - ii. Must be documented.
- D. Operator Interface.
 - 1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all relevant input and output points for that equipment. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 23 09 93.

2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.17 Control System Checkout and Testing

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
 1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
 6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
 7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

3.18 Control System Demonstration and Acceptance

- A. Demonstration.
 1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification.

These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.

2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

- d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
- 10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- B. Acceptance.
 - 1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
 - 2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.19 Cleaning

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.20 Training

- A. Provide training for a designated staff of Owner's representatives.
- B. Training shall enable students to accomplish the following objectives.
 - 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration
 - c. Understand DDC system components
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)

- e. Operate the workstation and peripherals
 - f. Log on and off the system
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual
 - k. Understand the job layout and location of control components
 - l. Access data from DDC controllers and ASCs
 - m. Operate portable operator's terminals
2. Advanced Operators:
- a. Make and change graphics on the workstation
 - b. Create, delete, and modify alarms, including annunciation and routing of these
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - d. Create, delete, and modify reports
 - e. Add, remove, and modify system's physical points
 - f. Create, modify, and delete programming
 - g. Add panels when required
 - h. Add operator interface stations
 - i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures
 - k. Perform DDC controller unit operation and maintenance procedures
 - l. Perform workstation and peripheral operation and maintenance procedures
 - m. Perform DDC system diagnostic procedures
 - n. Configure hardware including PC boards, switches, communication, and I/O points
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - p. Adjust, calibrate, and replace system components
3. System Managers/Administrators:
- a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures
- C. The instructor(s) shall be factory-trained and experienced in presenting this material.

3.21 Sequences of Operation

See Section 23, Appendix A (Sequences of Operation, With Points Lists).

3.22 Control Valve Installation

- A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- B. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- C. Valves shall be installed in accordance with the manufacturer's recommendations.
- D. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- E. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.
- F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1.5 inch in diameter, with ¼ inch high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

3.23 Control Damper Installation

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.24 Smoke Damper Installation

- A. The contractor shall coordinate all smoke and smoke/fire damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.
- B. Provide complete submittal data to controls system subcontractor for coordination of duct smoke detector interface to HVAC systems.

3.25 Duct Smoke Detection

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.26 Packaged Equipment Controls

- A. General. The electronic controls packaged with any equipment furnished under this contract shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.
- B. Distributed Processing. The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.
- C. I/O Capacity. The controller shall contain sufficient I/ O capacity to control the target system.
- D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.
- E. Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°C to 60°C (40°F to 140°F).
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- F. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- G. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.
- H. Power. Controller shall be able to operate at 90% to 110% of nominal voltage rating.
- I. Transformer. Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

3.27 Start-Up and Checkout Procedures

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 - 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 2. Verify that all analog and binary input/output points read properly.
 - 3. Verify alarms and interlocks.
 - 4. Verify operation of the integrated system.

APPENDIX A: Glossary of Terms

Terms used within the Specification Text:

- **Advanced Application Controller (AAC):**

A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.

- **Application Specific Controller (ASC):**

A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

- **BACnet/IP:**

An approved BACnet network type which uses an Ethernet carrier and IP addressing.

- **BACnet MS/TP:**

An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.

- **BACnet over ARCNET:**

An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.

- **Building Controller (BC):**

A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the

BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

- **Direct Digital Control (DDC):**

A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and other actuators which control the system, as opposed to indirectly controlling a system by resetting setpoints on an analog pneumatic or electronic controller.

- **PICS - Protocol Implementation Conformance Statement:**

A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.

- **Smart Actuator (SA):**

An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.)

- **Smart Sensor (SS):**

A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.)

- **Web services:**

Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

Terms used within the Sequences of Operation:

- **adj.**
Adjustable by the end user, through the supplied user interface.
- **AI, AO, etc. (Column Headings on Points List)**

AI = Analog Input. A physical input to the control module.

AO = Analog Output. A physical output from the control module.

AV = Analog Value. An intermediate (software) point that may be editable or read-only.

Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.

BI = Binary Input. A physical input to the control module.

BO = Binary Output. A physical output from the control module.

BV = Binary Value. An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.

Loop = A control loop. Most commonly a PID control loop. Typically a control loop will include a setpoint, an input which is compared to the setpoint, and an output which controls some action based upon the difference between the input and the setpoint. A PID control loop will also include gains for the proportional, integral, and derivative response as well as an interval which controls how frequently the control loop updates its output. These gains may be adjustable by the end user for control loop "tuning," but in self-tuning control loops or loops which have been optimized for a specific application the gains may not be adjustable.

Sched = Schedule. The control algorithm for this equipment shall include a user editable schedule.

Trend. The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)

Alarm. The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.

Note: If the specifications require use of the BACnet protocol, all of the above shall be provided as BACnet objects.

- **KW Demand Limiting: ***

An energy management strategy that reduces energy consumption when a system's electric power meter exceeds an operator-defined threshold.

When power consumption exceeds defined levels, the system automatically adjust setpoints, de-energizes low priority equipment, and takes other pre-programmed actions to avoid peak demand charges. As the demand drops, the system restores loads in a pre-determined manner.

- **Occupant Override Switch, or Timed Local Override:**

A control option that allows building occupants to override the programmed HVAC schedule for a limited period of time.

When the override time expires, the zone returns to its unoccupied state.

- **Occupant Setpoint Adjustment:**

A control option that allows building occupants to adjust - within limits set by the HVAC control system - the heating and cooling setpoints of selected zones. Typically the user interface for this function is built into the zone sensor.

- **Optimal Start-Up: ***

A control strategy that automatically starts an HVAC system at the latest possible time yet ensures comfort conditions by the time the building becomes occupied.

In a typical implementation, a controller measures the temperature of the zone and the outside air. Then, using design heating or cooling capacity at the design outside air temperature, the system computes how long a unit must run at maximum capacity to bring the zone temperature to its occupied setpoint.

The optimal start algorithm often includes a self-learning feature to adjust for variations from design capacity.

A distributed system must use Run on Request with Optimal Start. (See below.)

- **Requested, or Run on Request: ***

A control strategy that optimizes the runtime of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. Source equipment runs only when needed, not on a fixed schedule.

The source equipment runs when one or more receiving units request its services. An operator determines how many requests are required to start the source equipment.

For example, if all the zones in a building are unoccupied and the zone terminal units do not need heating or cooling, the AHU will shut down. However, if a zone becomes occupied or needs cooling, the terminal unit will send a run request to the AHU to initiate the start-up sequence. If this AHU depends on a central chiller, it can send a run request to the chiller.

The run on request algorithm also allows an operator to schedule occupancy for individual zones based on the needs of the occupants without having to adjust the schedules of related AHUs and chillers.

- **Trim and Respond, or Setpoint Optimization: ***

A control strategy that optimizes the setpoint of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service.

The source unit communicates with receiving units to determine heating, cooling, and other requirements, and then adjusts its setpoint.

For example, if all zones are comfortable and do not request cooling, the AHU will gradually increase (trim) its supply air setpoint. When a zone requests cooling, the AHU responds by dropping its setpoint. The more zones that request cooling, the more it drops the setpoint. The AHU repeats this process throughout the day to keep zones cool, but with a supply air setpoint that is no cooler than necessary.

Contracting Terms:

- **Furnished or Provided:**

The act of supplying a device or piece of equipment as required meeting the scope of work specified and making that device or equipment operational. All costs required to furnish the specified device or equipment and make it operational are borne by the division specified to be responsible for providing the device or equipment.

- **Install or Installed:**

The physical act of mounting, piping or wiring a device or piece of equipment in accordance with the manufacturer's instructions and the scope of work as specified. All costs required to complete the installation are borne by the division specified to include labor and any ancillary materials.

- **Interface:**

The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.

- **Integrate:**

The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.

APPENDIX B: Abbreviations

The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.

AC - Air Conditioning
ACU - Air Conditioning Unit
AHU - Air Handling Unit
AI - Analog Input
AO - Analog Output
AUTO - Automatic
AUX - Auxiliary
BI - Binary Input
BO - Binary Output
C - Common
CHW - Chilled Water
CHWP - Chilled Water Pump
CHWR - Chilled Water Return
CHWS - Chilled Water Supply
COND - Condenser
CW - Condenser Water
CWP - Condenser Water Pump
CWR - Condenser Water Return
CWS - Condenser Water Supply
DA - Discharge Air
EA - Exhaust Air
EF - Exhaust Fan
EVAP - Evaporators
FCU - Fan Coil Unit
HOA - Hand / Off / Auto
HP - Heat Pump
HRU - Heat Recovery Unit
HTEX - Heat Exchanger
HW - Hot Water
HWP - Hot Water Pump
HWR - Hot Water Return
HWS - Hot Water Supply
MAX - Maximum
MIN - Minimum
MISC - Miscellaneous
NC - Normally Closed
NO - Normally Open
OA - Outdoor Air
PIU - Powered Induction Unit

RA - Return Air
RF - Return Fan
RH - Relative Humidity
RTU - Roof-top Unit
SA - Supply Air
SF - Supply Fan
SP - Static Pressure
TEMP - Temperature
UH - Unit Heater
UV - Unit Ventilator
VAV - Variable Air Volume
VVTU - Variable Volume Terminal Unit
W/ - with
W/O - without
WSHP - Water Source Heat Pump

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PART 1: GENERAL

Section Includes

- 1.1 AC-1 & SA-1**
- 1.2 AC-2**
- 1.3 Two Boiler System**
- 1.4 Steam to Hot Water Converter (typical of 1)**

1.1 AC-1 & SA-1

Run Conditions:

The unit shall run as per the existing system and shall maintain:

- A 26.7°C (adj.) Leaving Air Temperature (LAT) setpoint.

Alarms shall be provided as follows:

- Low Supply Air Temp: If the supply air temperature is less than the heating setpoint by a user definable amount (adj.).

Freeze Protection:

The unit shall shut down and generate an alarm upon receiving a freezestat status.

Supply Fan:

The supply fan shall run as per the existing setup.

Heating Coil Steam Valve:

The controller shall measure the supply air temperature and modulate the heating coil steam valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- As per the existing system schedules.
- AND the supply air temperature is below heating setpoint.
- AND the supply fan status is on.
- AND the cooling is not active.

The heating coil steam valve shall open whenever the freezestat (if present) is on.

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Supply Air Temp	x								x		x
Heating Steam Valve		x							x		x
Freezestat			x						x	x	x
Heating Setpoint					x				x		x
High Supply Air Temp										x	
Low Supply Air Temp										x	
Totals	1	1	1	0	1	0	0	0	4	3	4

1.2 AC-2

Run Conditions:

The unit shall run as per the existing system and shall maintain:

- A 22°C (adj.) heating setpoint.

Alarms shall be provided as follows:

- High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
- Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

Freeze Protection:

The unit shall shut down and generate an alarm upon receiving a freezestat status.

Supply Fan:

The supply fan shall run as per the existing setup.

Heating Coil Steam Valve:

The controller shall measure the zone temperature and modulate the heating coil steam valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- As per the existing system schedules.
- AND the zone temperature is below heating setpoint.
- AND the supply fan status is on.
- AND the cooling is not active.

The heating coil steam valve shall open whenever the freezestat (if present) is on.

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Zone Temp	x								x		x
Heating Steam Valve		x							x		x
Freezestat			x						x	x	x
Heating Setpoint					x				x		x
Low Zone Temp										x	
Totals	1	1	1	0	1	0	0	0	4	2	4

1.3 Two Boiler System

Boiler System - Run Conditions:

The boiler system shall be enabled to run whenever outside air temperature is less than 18.5°C (adj.).

To prevent short cycling, each boiler shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.

Each boiler shall run subject to its own internal safeties and controls.

The boiler system shall also run for freeze protection whenever the outside air temperature is less than 3°C (adj.).

Boiler Safeties:

The following safeties shall be monitored:

- Boiler alarm.

Alarms shall be provided as follows:

- Boiler alarm.

Boiler Lead/Lag Operation:

The two boilers shall operate in a lead/lag fashion.

- The lead boiler shall run first.
- On failure of the lead boiler, the lag boiler shall run and the lead boiler shall turn off.
- When OAT (Outdoor Air Temperature) < 20°C (adj), the lead boiler will be enabled, and will be commanded a steam pressure setpoint (SP1_SP) of 10PSI (adj), the unit will cycle on when the steam header pressure is 2PSI (adj.) below SP1_SP, and will cut out when Steam pressure is 2 PSI above SP1_SP. The boiler minimum runtime will be 15 minutes(adj.).

- Note: The maximum permissible pressure in the header is 13PSI, the BAS must disable all boilers at this point
- When $OAT < -10^{\circ}\text{C}$ (adj.), the second boiler will be enabled and be commanded a steam pressure setpoint $SP2 = SP1 - 1\text{PSI}$ (adj.), the range for the lag boiler is 2PSI (adj.), and the minimum runtime is 15 minutes (adj.).

The designated lead boiler shall rotate upon one of the following conditions: (user selectable):

- manually through a software switch
- if boiler runtime (adj.) is exceeded
- daily
- weekly
- monthly

Alarms shall be provided as follows:

- Boiler 1
 - Failure: Commanded on, but the status is off.
 - Running in Hand: Commanded off, but the status is on.
 - Runtime Exceeded: Status runtime exceeds a user definable limit.
- Boiler 2
 - Failure: Commanded on, but the status is off.
 - Running in Hand: Commanded off, but the status is on.
 - Runtime Exceeded: Status runtime exceeds a user definable limit.
- Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.

Header Pressure Monitoring:

The following pressures shall be monitored:

- Header supply pressure.

Alarms shall be provided as follows:

- High Header Supply Pressure: If greater than 13 PSI.

Feed Water Pumps:

The feed water pumps shall run based on mechanical boiler level controls.

The following shall be monitored:

- Feed Water Pump Status.

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Header Supply Pressure	x								x		x
Boiler 1 Alarm Status			x						x	x	x
Boiler 1 Status			x						x		x
Boiler 2 Alarm Status			x						x	x	x
Boiler 2 Status			x						x		
Feed Water Pump 1 Status			x						x		x
Feed Water Pump 2 Status			x						x		x
Boiler 1 Enable				x							x
Boiler 2 Enable				x							x
Outside Air Temp					x						x
Boiler 1 Failure										x	
Boiler 1 Running in Hand										x	
Boiler 1 Runtime Exceeded										x	
Boiler 2 Failure										x	
Boiler 2 Running in Hand										x	
Boiler 2 Runtime Exceeded										x	
Lead Boiler Failure										x	x

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Totals	1	0	6	2	1	0	0	0	7	9	10

1.4 Steam to Hot Water Converter (typical of 1)

Heat Exchanger System Run Conditions:

The heat exchanger system shall be enabled to run the circulation pump is running:

Hot Water Supply Temperature Setpoint:

The hot water supply temperature setpoint shall be a fixed setpoint of 82°C (adj.).

Alarms shall be provided as follows:

- High Hot Water Supply Temp: If greater than 93°C (adj.).
- Low Hot Water Supply Temp: If less than 38°C (adj.).

Heat Exchanger Steam Valve - Hot Water Control:

The controller shall measure the hot water supply temperature and modulate the steam valve to maintain its setpoint.

The steam valve shall be enabled whenever:

- The heat exchanger is called to run.
- AND hot water supply temperature is below setpoint.

The steam valve shall close whenever the hot water supply temperature rises from 82°C to 93°C (adj.).

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Hot Water Supply Temp	x								x		x
Steam Valve		x							x		x
High Hot Water Supply Temp										x	
Low Hot Water Supply Temp										x	
Totals	1	1	0	0	0	0	0	0	2	2	2

PART 1 - GENERAL

- 1.1 SUMMARY .1 Not used.
- 1.2 REFERENCES .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.3 – 2016, Malleable Iron Threaded Fittings: Classes 150 and 300
- .2 ASME B16.5 - 2017, Pipe Flanges and Flanged Fittings.
- .3 ASME B16.18 - 2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .4 ASME B16.22 - 2013, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .5 ASME B18.2.1 - 2012, Square and Hex Bolts and Screws Inch Series.
- .3 American Society for Testing and Materials International (ASTM)
- .1 ASTM A47/A47M – 99 (2014), Standard Specification for Ferritic Malleable Iron Castings.
- .2 ASTM A53/A53M - 18, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .3 ASTM A106/A106 M – 18, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- .4 ASTM A179/A179M – 90a (2012), Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
- .5 ASTM B75M - 11, Standard Specification for Seamless Copper Tube [Metric].
- .6 ASTM B837 - 10, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .7 ASTM B88 – 16, Standard Specification for Seamless Copper Water Tube
- .4 Canadian Standards Association (CSA International)
- .1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .5 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
- .1 CAN/CSA B149.1-15, Natural Gas and Propane Installation Code Handbook.
- .2 CAN/CSA B149.2-15, Propane Storage and Handling Code.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
- .1 Submit manufacturer's printed product literature, specifications and datasheets for fixtures and equipment.
- .2 Indicate dimensions, performance, construction details and materials for specified items.
- .3 Shop Drawings:
- .1 Submit shop drawings to indicate materials, finishes, method of anchorage, dimensions, construction and assembly details and accessories for the following:

		<ul style="list-style-type: none">.1 Shut off valves (including manual, solenoid and seismic actuated shut off valves).2 Pressure regulators.3 Pressure relief valves.4 Strainers..5 Emergency gas control valves and boxes.6 Manufactured roof top pipe supports.7 Laboratory outlets.8 Natural gas barbeque outlets.9 Secondary gas meters
	4	Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
	.5	Instructions: submit manufacturer's installation instructions.
	.6	Closeout submittals: <ul style="list-style-type: none">.1 Closeout submittals shall be in accordance with Section 01 78 00 Closeout Submittals..2 Submit maintenance and engineering data for incorporation into maintenance manuals.
1.4 QUALITY ASSURANCE	.1	Health and Safety: <ul style="list-style-type: none">.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
	.1	All materials shall comply with manufacturer's specifications and referenced documents.
	.	
1.5 DELIVERY, STORAGE AND HANDLING	.1	Waste Management and Disposal: <ul style="list-style-type: none">.1 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP)..2 Remove from site and dispose of packaging materials at appropriate recycling facilities..3 Place materials defined as hazardous or toxic in designated containers..4 Fold up metal banding, flatten and place in designated area for recycling.
PART 2 - PRODUCTS		
2.1 GAS SERVICE	.1	Arrange with the local utility provide the gas meter and to have the gas service provided to the gas meter where indicated.
	.2	Pay fees and charges requested by the local utility to provide the gas service and meter.
	.3	Submit all plans as requested by the local utility.
2.2 PIPE	.1	Steel pipe: to ASTM A 53/A 53M, Schedule 40, seamless as follows: <ul style="list-style-type: none">.1 NPS 1/2 to 2, screwed.

	.2	NPS 2 1/2 and over, plain end.
2.3 JOINTING MATERIAL	.1	Screwed fittings: pulverized lead paste.
	.2	Welded fittings: to CSA W47.1.
	.3	Flange gaskets: nonmetallic flat.
	.4	Brazing: to ASTM B837.
2.4 FITTINGS	.1	Steel pipe fittings, screwed, flanged or welded:
	.1	Malleable iron: screwed, banded, Class 150.
	.2	Steel pipe flanges and flanged fittings: to ASME B16.3.
	.3	Welding: butt-welding fittings.
	.4	Unions: malleable iron, brass to iron, ground seat, to ASTM A 47/A 47M.
	.5	Bolts and nuts: to ASME B18.2.1.
	.6	Nipples: schedule 40, to ASTM A 53/A 53M.
2.5 VALVES	.1	Certified as defined in CSA B149.1-15, lubricated plug, ball or eccentric type suitable for the temperature to which they are exposed.
2.5 PRESSURE REGULATING VALVES	.1	High tensile iron body with synthetic rubber diaphragm and valve disc.
	.2	CSA listed for use with natural gas.
2.5 STRAINERS	.1	Y strainer suitable for natural gas application and system pressure requirements.
	.2	Carbon steel construction with stainless steel screens.
	.3	Up to NPS 2: Threaded or socket welded.
	.4	NPS 2-1/2 and over: Flanged
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 PIPING	.1	Install in accordance with CAN/CSA B149.1, supplemented as specified.
	.2	Install drip points:
	.1	At low points in piping system.
	.2	At connections to equipment.
3.3 VALVES	.1	Install valves with stems upright or horizontal unless otherwise approved by Consultant.

- .2 Install natural gas manual isolation valves complete with handles at the following locations:
 - .1 At branch take-offs to isolate pieces of equipment, and as indicated.
 - .2 At all locations shown on the drawings.
 - .3 At each branch supply line from a common meter set.
 - .4 At the service entry point to each building immediately prior to entry.
 - .5 At each branch or riser connection from the main.
 - .6 Immediately upstream of all pressure regulating valves.
 - .7 At each service to each laboratory (install valves in readily accessible locations).
 - .8 At each service to each laboratory bench (install valves in readily accessible locations).
 - .3 All building isolation valves shall possess locking lugs.
- 3.4 PRESSURE
REGULATING VALVES
- .1 Install pressure regulating valves in each equipment room or at each piece of equipment where the natural gas supply pressure exceeds low pressure ("W.C.).
 - .2 Pipe the relief vent ports full diameter to atmosphere in accordance with the requirements of CSA B149.1-15, Natural Gas and Propane Installation Code.
- 3.5 FIELD QUALITY
CONTROL
- .1 Site Tests/Inspection:
 - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.
 - .2 Examine all joints for leaks and remake all leaking joints with new materials.
 - .3 Purge all piping after pressure tests in accordance with CSA B149.1-15, Natural Gas and Propane Installation Code.
 - .4 Submit copies of pressure test reports for all sections of piping.
- 3.6 ADJUSTING
- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.
 - .2 Pre-Start-Up Inspections:
 - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
 - .2 Check gas trains, entire installation is approved by authority having jurisdiction.
- 3.7 CLEANING
- .1 Cleaning: in accordance with Section CAN/CSA B149.1, supplemented as specified.
 - .2 Perform cleaning operations as specified in Section 01 74 11 Cleaning and in accordance with manufacturer's recommendations.
 - .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

- | | | |
|---|----|--|
| 1.1 RELATED REQUIREMENTS | .1 | Not used. |
| | | |
| 1.2 REFERENCES | .1 | The latest revisions of the following standards shall apply unless noted otherwise. |
| | .2 | American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME) <ul style="list-style-type: none">.1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings: Class 25, 125, 250 and 800..2 ASME B16.25, Buttwelding Ends..3 ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300..4 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS ½ through 24..5 ANSI/ASME B16.9, Factory-Made Wrought Steel Buttwelding Fittings..6 ANSI B18.2.1, Square and Hex Bolts and Screws (Inch Series)..7 ANSI/ASME B18.2.2, Square and Hex Nuts (Inch Series)..8 ASME B31.9-17 Building Services Piping. |
| | .2 | American National Standards Institute (ANSI) / American Water Works Association (AWWA) <ul style="list-style-type: none">.1 ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings. |
| | .3 | ASTM International Inc. <ul style="list-style-type: none">.1 ASTM A 47/A 47M, Standard Specification for Ferritic Malleable Iron Castings..2 ASTM A 53/A 53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless..3 ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings..3 ASTM A106/A106M, Standard Specification For Seamless Carbon Steel Pipe For High-Temperature Service |
| | .4 | Not Used. |
| | .5 | Canadian Standards Association (CSA International) <ul style="list-style-type: none">.1 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding..2 CSA-B51 Boiler, pressure vessel, and pressure piping code. |
| | .6 | Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. <ul style="list-style-type: none">.1 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends..2 MSS-SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends..3 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves..4 MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends. |
| | | |
| 1.3 ACTION AND INFORMATIONAL SUBMITTALS | .1 | Submittals in accordance with Section 01 33 00 - Submittal Procedures. |
| | .2 | Submit product data and include manufacturer's literature data sheets for following: <ul style="list-style-type: none">.1 Valves. |

- .3 Submit shop drawings: Stamped and signed by Contractor as reviewed.
- .4 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - .1 Special servicing requirements.
- 1.4 CLOSEOUT SUBMITTALS
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - .1 Special servicing requirements.
- 1.5 DELIVERY, STORAGE AND HANDLING
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- 1.6 EXTRA MATERIALS
 - .1 Provide following spare parts:
 - .1 Valve seats: one for every ten valves, each size. Minimum one.
 - .2 Discs: one for every ten valves, each size. Minimum one.
 - .3 Stem packing: one for every ten valves, each size. Minimum one.
 - .4 Valve handles: two of each size.
 - .5 Gaskets for flanges: one for every ten flanges.
- 1.7 QUALITY ASSURANCE
 - .2 Pipe welding:
 - .1 Installation and repair or alterations to, pressure piping systems shall be performed only by licensed Contractors and licensed Welders, certified for the work being done in accordance with the Regulations and Requirements of the Province.
 - .2 All field welding to be in accordance with the procedures of CSA-W117.2 and the current edition of ASME/ANSI B31.1 or B31.9 Code.
 - .3 The Contractor shall submit names and qualifications of all personal (including subtrades) intended for this project within twenty-one (21) days of contract award. The Owner reserves the right to accept or reject any individual proposed for the project, based on qualifications.
 - .4 Welders must be qualified for the process for which they are welding in. Typical field welding processes are listed below:
 - .1 SMAW (Shielded Metal Arc Welding) also known as stick welding
 - .2 FCAW (Flux-cored arc welding) also known as wire welding
 - .5 Welders Qualifications
 - .1 Welding qualifications in accordance with CSA B51
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Furnish welder's qualifications to Owner's Representative.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - .6 Inspectors Qualifications
 - .1 Inspectors qualified to CSA W178.2.
- PART 2 - PRODUCTS
- 2.1 SUSTAINABLE
 - .1 Not used.

REQUIREMENTS

- 2.2 PIPE
- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 Steam;
 - .1 To NPS 1 1/2: Schedule 80.
 - .2 NPS 2 and over: Schedule 40.
 - .2 Condensate: Schedule 80.
- 2.3 PIPE JOINTS
- .1 NPS 2 and under: screwed fittings with PTFE tape.
 - .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
 - .3 Flanges: plain or raised face. Flange gaskets to ANSI/AWWA C111/A21.11.
 - .4 Pipe thread: taper.
 - .5 Bolts and nuts: carbon steel, to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2.
 - .6 Buttwelding ends: to ANSI/ASME B16.25.
- 2.4 FITTINGS
- .1 Pipe flanges: cast-iron to ANSI/ASME B16.1, Class 150.
 - .2 Screwed fittings: malleable iron to ANSI/ASME B16.3, Class 150.
 - .3 Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.
 - .4 Buttwelding fittings: steel to ANSI/ASME B16.9.
 - .5 Unions: malleable iron, to ASTM A47/A47M.
- 2.5 VALVES
- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2 1/2 and larger:
 - .1 Equipment: Flanged ends.
 - .2 Elsewhere: Flanged ends.
 - .2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 2- Valves.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23- Valves.
 - .2 NPS 2 1/2 -8:
 - .1 Mechanical Rooms: Class 150, rising stem, split wedge disc, cast iron, lead- free trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
 - .2 Elsewhere: Class 150, Non- rising stem, solid wedge disc, cast iron with lead- freetrim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.

- .3 NPS 10 and over:
 - .1 Mechanical Rooms: Class 150, rising stem, split wedge disc, cast steel with lead- freetrim, as specified Section 23 05 23- Valves.
 - .2 Elsewhere: Class 150, Non- rising stem, solid wedge disc, cast steel with lead- freetrim, as specified Section 23 05 23- Valves.
 - .3 Globe valves: Application: Steam service, throttling, flow control, emergency bypass.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PFTE disc as specified Section 23 05 23- Valves.
 - .2 Elsewhere: with composition disc as specified Section 23 05 23- Valves.
 - .2 NPS 2 1/2 and over:
 - .1 With composition disc, cast iron with bronze trim, to Section 23 05 23- Valves.
 - .4 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23- Valves.
 - .5 Bypass valves around large size gate valves: as specified Section 23 05 23- Valves.
 - .6 Lift check valves:
 - .1 NPS 2 and under: Class 125, lift, with composition disc, as specified Section 23 05 23- Valves.
 - .2 NPS 2 1/2 and over: as specified Section 23 05 23- Valves.
 - 2.6 VALVE OPERATORS
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Rooms.
- PART 3 - EXECUTION
- 3.1 APPLICATION
 - .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
 - 3.2 PIPING
 - .1 Group piping in pipeways wherever possible for neatness and operability. All piping shall be routed in an orderly manner and to maintain proper grades.
 - .2 Relative elevations of pipeways shall be set to provide sufficient clearance between lines at intersections, to conserve head room and interfere as little as possible with the use of space.
 - .3 Flat turns at change in direction shall be avoided.
 - .4 Dead ends and pockets in piping shall be avoided.
 - .5 Ream pipe ends. Clean scale and dirt, inside and outside, before and after assembly.

- .6 During construction, protect openings in piping and equipment, by capping or plugging to prevent entry of dirt.
- .7 Provide clearance for installation of insulation and access for maintenance of equipment, valves, and fittings.
- .8 Use long radius elbows.
- .9 Screw or weld (unless otherwise specified) piping systems up to NPS 2.
- .10 Weld (unless otherwise specified) piping systems NPS 2-1/2 and over.
- .11 Weld underground piping.
- .12 Make reductions in condensate and steam pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for condensate, bottom flat for steam.
- .13 Pipe the discharge from steam safety relief valves and vents to the outside.
- .14 Pipe discharge from equipment blowdowns, and overflows to the nearest building drain.
- .15 Provide clearance for proper installation of insulation, for access of valves, air vents, drains, and unions.
- .16 Connect branch lines into top of mains.
- .17 Drip pocket: line size diameter and 300 mm in height.
- .18 Piping Grading
 - .1 Grade piping to provide positive drainage and venting. Slope as follows:
 - .2 Steam mains – down in direction of flow, minimum 0.5%
 - .3 Condensate mains and branches – down in direction of flow, minimum 0.75%. Provide steam trap stations at bottom of risers and low points.
 - .4 Provide steam trap stations at bottom of risers and low points.

3.3 EXPANSION OF PIPING

- .1 Install piping systems with due regard and provision for expansion.
- .2 Provide anchors, where shown. Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.
- .3 Expansion loops shall be welded construction with long radius elbows.
- .4 Install expansion loops, cold sprung 50% of calculated expansion.

3.3 VALVES & STRAINERS

- .1 Install globe valves around, NPS 8 and over, gate valves.
- .2 Install valves with stem upright or horizontal, not inverted.
- .3 Provide drain valves at low points of piping.

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- | | | |
|-----------------------------------|----|---|
| | .4 | Provide valved drain and hose connection off the bottom of all strainers. |
| 3.4 TESTING | .1 | Notify Consultant and Inspection Authority having jurisdiction, 48 hours in advance of intended test dates. |
| | .2 | Before testing piping, isolate equipment which cannot withstand test pressure. |
| | .3 | Examine systems under test for leaks. |
| | .4 | Joints shall remain dry during test. General sweating around weld shall be reason for rejection. |
| | .5 | Remake leaking connections and joints. |
| | .6 | Tests shall be limited to new piping only. |
| | .7 | New connections to existing piping shall be warranted. |
| | .8 | Initial Hydrostatic test: (Steam and Condensate) |
| | .1 | 200% of working pressure, but not less than 861 kPa (125 psi) for 1 working day. |
| | .9 | Final Hydrostatic test: (Steam and Condensate) |
| | .1 | 150% of working pressure, after piping connections to equipment is complete. Maintain until piping systems have been inspected. |
| 3.5 SYSTEM START-UP | .1 | In accordance with Section 21 05 01 Common Work Results for Mechanical. |
| 3.6 PERFORMANCE VERIFICATION (PV) | .1 | General: |
| | .1 | Verify performance in accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems supplemented as specified herein. |
| | .2 | Timing, only after: |
| | .1 | Pressure tests successfully completed. |
| | .2 | Flushing as specified has been completed. |
| | .3 | Water treatment system has been commissioned. |
| | .3 | PV Procedures: |
| | .1 | Verify complete drainage of condensate from steam coils. |
| | .2 | Verify proper operation of system components, including, but not limited to: |
| | .1 | Steam traps - verify no blow-by. |
| | .2 | Flash tanks. |
| | .3 | Thermostatic vents. |
| | .3 | Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors. |
| | .4 | Not used. |
| | .5 | Not used. |

3.7 CLEANING

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

END OF SECTION

PART 1 - GENERAL

- | | | |
|---|----|---|
| 1.1 RELATED REQUIREMENTS | .1 | Not used. |
| 1.2 REFERENCES | .1 | The latest revisions of the following standards shall apply unless noted otherwise. |
| | .2 | American Society for Mechanical Engineers (ASME International) |
| | .3 | ASTM International Inc. <ul style="list-style-type: none">.1 ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings..2 ASTM A 167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip..3 ASTM A 216/A 216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service..4 ASTM A 240/A 240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications..5 ASTM A 276, Standard Specification for Stainless Steel Bars and Shapes..6 ASTM A 278/A 278M, Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C)..7 ASTM A 351/A 351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts..8 ASTM A 564/A 564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes..9 ASTM B 62, Standard Specification for Composition Bronze or Ounce Metal Castings. |
| | .4 | Canadian Standards Association <ul style="list-style-type: none">.1 CSA B51, Boiler, pressure vessel, and pressure piping code..2 CSA B2147, Installation code for hydronic heating systems. |
| | .5 | Health Canada/Workplace Hazardous Materials Information System (WHMIS) <ul style="list-style-type: none">.1 Material Safety Data Sheets (MSDS). |
| 1.3 ACTION AND INFORMATIONAL SUBMITTALS | .1 | Provide submittals in accordance with Section 01 33 00 - Submittal Procedures. |
| | .2 | Product Data: <ul style="list-style-type: none">.1 Provide manufacturer's printed product literature Canadian Registration Number (CRN), and datasheets for steam traps, vacuum breakers, pressure reducing valves, air vents, safety relief valves, and include product characteristics, performance criteria, physical size, finish and limitations. |
| | .3 | Shop Drawings: <ul style="list-style-type: none">.1 Provide drawings indicating make, model, sizing information, and installation instructions. |
| | .4 | Not used. |
| | .5 | Closeout Submittals: <ul style="list-style-type: none">.1 Provide maintenance data for incorporation into manual specified in |

Section 01 78 00 - Closeout Submittals and include following:

.1 Special servicing requirements.

1.4 DELIVERY,
STORAGE AND
HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

PART 2 - PRODUCTS

2.1 STEAM TRAPS

.1 General:

- .1 Select steam traps to pass 300% of the required condensate load except for thermodynamic type traps. For laundry equipment, select steam traps to pass 800% of the required condensate load.
- .2 All steam traps in each category shall be the product of a single manufacturer.

.2 Float and Thermostatic Steam Traps - 0 to 1035 kPa (150 psig).

- .1 Application: For modulating service on heating coils, heat exchangers.
- .2 Cast iron or semi steel body, screwed connections.
- .3 Stainless steel float, lever mechanism, and replaceable seat.
- .4 Stainless steel or phosphor bronze balanced pressure thermostatic air vent.

.3 Inverted Bucket Steam Traps - 0 to 1035 kPa (150 psig).

- .1 Application: For non-modulating steam services on end of line steam drips (drip legs), humidifiers.
- .2 Cast iron or semi steel, screwed connections.
- .3 Stainless steel bucket, lever mechanism on replaceable seat.
- .4 Bimetal air vent.

.4 Thermostatic Steam Traps - 0 to 450 kPa (65 psig).

- .1 Application: Where large air venting capacity required and for modulating steam service on hospital equipment.
- .2 Bronze or stainless steel body and cap, screwed with male union connection.
- .3 Stainless steel or phosphor bronze bellows and replaceable stainless steel valve.

.5 Thermodynamic Disc Steam Traps - 0 to 1035 kPa [150 psig].

- .1 Application: Steam tracing, process equipment.
- .2 Stainless steel body.
- .3 Hardened stainless steel disc.
- .4 Monel seat gasket.

2.2 VACUUM BREAKERS –
BALL TYPE

- .1 Application: On inlets to steam coils, heat exchangers and as indicated.
- .2 Stainless steel body.
- .3 Stellate seat and hardened stainless steel ball.

	.4	Cadmium plated retainer spring.
2.3 PRESSURE REDUCING VALVE EXTERNAL PILOT OPERATED	.1	Self operating, external pilot, single seat, diaphragm operated, dead end shutoff, enclosed spring chamber main and pilot valve.
	.2	Connections: .1 NPS 2 and under: screwed ends. .2 NPS 2-1/2 and over: flanged ends.
	.3	Main valve: .1 Cast iron valve body, stainless steel diaphragm, stainless steel seat rings, stem and disc
	.4	Pilot valve: .1 Cast iron valve body, stainless steel diaphragm
	.5	Capacity as scheduled
2.4 SAFETY AND RELIEF VALVES	.1	NPS 2 and under: .1 Bronze screwed body and bonnet, bronze or copper alloy trim.
	.2	NPS 2-1/2 and over: .1 Cast iron flanged body and bonnet, stainless steel trim.
	.3	Suitable for maximum operating pressure.
	.4	ASME tested.
	.5	Lifting lever handle.
	.6	Selected for 90% of actual capacity at 10% accumulation.
2.5 STEAM SEPARATOR	.1	Minimum Requirements: .1 Centrifugal entrainment steam separator. .2 Steel body, stainless steel internal element. .3 Designed and constructed in accordance with ASME Code requirements. .4 Efficiency: 99% removal of all liquid and solid entrainment where particle size exceeds 10 microns.
2.6 DRIP PAN ELBOWS	.1	Application: on discharge of steam safety relief valves.
	.2	Cast iron or steel with screwed or flanged inlet and threaded drain connections.
2.7 STRAINERS	.1	Service 1034 kPa (150 psi) and below: .1 NPS ½ to NPS 1-1/2. Class 300, flanged ends, cast carbon steel, Y-pattern, sediment separator with 0.8 mm. 304 stainless steel screen. Provide min NPS ½ drain cock. .2 NPS 2 to 12: Class 300, flanged ends, cast carbon steel, Y-pattern, sediment separator with 304 stainless steel screen. 1.2mm screen for sizes up to 100 mm4", 1.6 mm. screen for sizes over 100 mm. Provide min. NPS ½ drain cock.

- .2 Service 860 kPa (125 psi) and below:
 - .1 NPS 1/2 to 3: Class 150, 1 MPa, cast iron body to ASTM A278/A278M, Class 30, Y pattern with 20 x 20 mesh Monel screen, screwed ends.
 - .2 NPS 2 to 12: Class 300, flanged ends, cast carbon steel, Y-pattern, sediment separator with 304 stainless steel screen. 1.2mm screen for sizes up to 100 mm⁴", 1.6 mm. screen for sizes over 100 mm. Provide min. NPS ½ drain cock.
 - .3 Service 2 mPa (290 psi) and below:
 - .1 NPS 1/2 to 2: Class 600, 4 MPa, screwed ends, cast carbon steel body to ASTM A216/A216M, Grade WCB, Y pattern with 20 x 20 mesh, Type 304 stainless steel screen, steel cap to ASTM A108, Grade 117.
- 2.8 FLASH TANKS
 - .1 Tank(s): vertical or horizontal type as scheduled with welded or flanged drop tube connections.
 - .2 Size[s]: as indicated on the drawings.
 - .3 Construction: to ASME code.
 - .4 Maximum working pressure: 860 kPa (125 psi).
 - .5 Connections: NPS 2 and under, screwed; NPS 2-1/2 and over, flanged.
 - .6 Finish: prime coated.
 - .7 Supports: vertical legs for vertical tank; saddles for horizontal tank.
- 2.9 BLOWDOWN TANKS
 - .1 Sized to accommodate the blowdown volume of the single-largest connected boiler in the system, as defined by CSA B-51 - 2019.
 - .2 Wall thickness of the vessel shall include a corrosion allowance of not less than 3mm.
 - .3 Required connections:
 - .1 Inlet connection Routed to top.
 - .2 Overflow to drain (internal vented diptube to tank bottom 20% volume).
 - .3 Valved drain.
 - .4 Vent to Atmosphere.
 - .5 DCW inlet.
 - .6 Thermowell.
 - .4 Tank assembly must include a refrigerant pilot-operated thermostatic valve.
 - .5 Tank Assembly must include tri-support legs to ground level.
 - .6 Tank body long-axis shall be in the vertical direction.
 - .7 Not used.
 - .8 Pressure vessel to be inspected and approved by Authority Having Jurisdiction (ie. Boiler Inspector) prior to being put into operation.
- 2.9 SAMPLE COOLER
 - .1 Shell and tube heat exchanger designed for steam condensation.

	.2	Complete with the following connections: <ul style="list-style-type: none">.1 13mm DCW inlet (FNPT)..2 13mm DCW outlet (FNPT)..3 13mm steam inlet (FNPT)..4 13mm sample condensate outlet.
	.3	Constructed of 304 stainless steel.
	.4	150 PSI MAWP, 250°C temperature.
	.5	Not used.
PART 3 - EXECUTION		
3.1 APPLICATION	.1	Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
	.2	Maintain proper clearance around equipment to permit maintenance.
3.2 STEAM TRAPS	.1	Install unions on inlet and outlet.
	.2	Install ahead of each trap, a 300 mm (12") minimum vertical cooling leg at full size and a 150 mm (6") dirt pocket, an isolating gate valve, a strainer and a union.
	.3	Install after each trap, a union, a check valve, and an isolating gate valve.
	.4	Install a bypass, complete with globe valve, where indicated.
	.5	Install blow off valves on strainers NPS 1 and larger.
	.6	Install a second gate valve (socket weld) on mains steam traps on steam lines at pressures at or above 688kPa (100 psig).
	.7	Provide a minimum NPS ¾ traps for drip legs serving steam mains and branches.
	.8	Application: <ul style="list-style-type: none">.1 Install thermostatic steam trap on steam radiation units, convectors and other similar terminal heating units..2 Install float and thermostatic steam traps on unit heaters, convectors, heating coils, heat exchangers, steam separators, flash tanks, steam jacketed equipment, and direct steam injected equipment..3 Install inverted bucket steam traps on humidifiers, steam main headers, and branch lines.
3.3 VACUUM BREAKERS – BALL TYPE	.1	Install vacuum breakers and check valves on steam coils and heat exchangers with modulated steam supply to control induced vacuum.
	.2	Location where shown on the drawings.
3.4 PRESSURE REDUCING VALVE EXTERNAL PILOT OPERATED	.1	Install steam pressure reducing valves, complete with strainer, isolating valves, bypass and steam relief valve where shown on the drawings.

- | | | |
|------------------------------|----|--|
| | .2 | Install in strict accordance with the manufacturers installation instructions. |
| | .3 | Observe all manufacturer's minimum dimension requirements upstream and downstream from valve. |
| | .4 | Where space permits install straight upstream and downstream lengths for the following valve sizes accordingly: <ul style="list-style-type: none">.1 NPS ½ to NPS 1-1/2<ul style="list-style-type: none">.1 Upstream 900mm (36").2 Downstream 1420mm (56").2 NPS 2 to NPS 4<ul style="list-style-type: none">.1 Upstream 1000mm (40").2 Downstream 1520mm (60") |
| 3.5 SAFETY AND RELIEF VALVES | .1 | Install steam pressure relief valves, downstream from steam pressure reducing valves to protect the low pressure piping system. |
| | .2 | Control line for pilot operator shall connect a minimum of 10 pipe diameters downstream to ensure true pressure. |
| | .3 | Relief valves shall discharge through drip pan elbows. |
| | .4 | Pipe relief valve discharge to atmosphere independent of other vents and in accordance with applicable code. |
| | .5 | Relief valve discharge piping shall terminate 2100 mm (84") minimum above the roof (personnel hazard). |
| | .6 | Provide a secure mesh cap to prevent foreign material entry. |
| | .7 | Support discharge pipe against reaction forces and to take up thermal movement. |
| 3.6 DRIP PAN ELBOWS | .1 | Install on discharge of safety/relief valve outlets. |
| | .2 | Install a 300 mm (12") long riser nipple in exhaust outlet connection and centre nipple inside the vent pipe. Nipple to slide freely into vent pipe riser. |
| | .3 | Pipe drip pan elbow drain connections full size to the nearest building drain. |
| 3.7 STRAINERS | .1 | Install strainers ahead of steam traps, pressure reducing valves, meters, control valves, and where shown on the drawings. |
| | .2 | Install blow off globe valves, on strainers 25 mm (1") and larger with inlet and outlet nipples. Install nipple and cap on smaller sizes. |
| | .3 | Ensure clearance for removal of basket. |
| | .4 | Do not install strainers in steam connections to non-freeze preheat coils. |
| 3.8 PERFORMANCE VERIFICATION | .1 | In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems. |
| 3.9 CLEANING | .1 | Clean in accordance with Section 01 74 11 - Cleaning. |

- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

- | | | |
|---|----|--|
| 1.1 SUMMARY | .1 | Related Requirements
.1 Not used, |
| 1.2 REFERENCES | .1 | The latest revisions of the following standards shall apply unless noted otherwise. |
| | .2 | Applicable Building Code - Refer to Section 21 05 01 – Common Work Results for Mechanical |
| | .3 | American Society for Testing and Materials International (ASTM)
.1 ASTM E202 Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols. |
| | .4 | American Society of Mechanical Engineers (ASME)
.1 ASME Boiler and Pressure Vessel Code, Section VII. |
| | .5 | 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 | Not used. |
| | .3 | Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties. |
| | .4 | Closeout Submittals:
.1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
.2 Include following:
.1 Log sheets as recommended by manufacturer |
| 1.4 QUALITY ASSURANCE | .1 | Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements. |
| 1.5 DELIVERY, STORAGE, AND HANDLING | .1 | Packing, shipping, handling and unloading:
.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements. |
| 1.6 GENERAL | .1 | Equipment, chemicals, testing, and service shall be provided by one supplier. |

- .2 Chemical treatment agency shall provide equipment, chemicals, and site supervision so as to fully comply with all requirements and their intent contained within this specification section.
- .3 Perform the cleaning, degreasing operation and initial water treatment and submit written reports on all situations found, actions taken and final results. Reports shall be signed by the chemical treatment agency. Inform the Consultant fifteen (15) working days prior to commencing of work.
- .4 Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, and mechanical contractor.
- .5 Chemical treatment agency shall provide directive and assistance to the mechanical Contractor in the degreasing, cleaning, and chemical treatment of all piping systems. Use of the permanent mechanical systems for pumping or heating of cleaning and dilution solutions is not permitted. Permanent systems shall be isolated and portable pumps and boilers utilized for the duration of the cleaning process. Permanent equipment shall be flushed, degreased, and chemically treated independent of the piping systems.
- .6 Confirm chemical treatment products are compatible with piping materials, seals, and gaskets used on this project prior to use.

PART 2 - PRODUCTS

2.1 SUSTAINABLE REQUIREMENTS

- .1 Not used.

2.2 MANUFACTURER

- .1 Equipment, chemicals, service provided by one supplier.

2.3 LOW PRESSURE FOR STEAM SYSTEM CHEMICAL TREATMENT

- .1 The low pressure steam chemical treatment system to consist of additional of a multiblend chemical into the boiler feedwater tank for purpose of scale and corrosion control, a separate sulfite addition vessel and pumpset shall be provided and connected to the feedwater tank.
- .2 Prior to chemical treatment all low pressure steam and condensate return piping to be mechanically cleaned in accordance with the requirements of Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .3 The addition of chemical to be based upon dual set point control (In-Range and Out-of-Range) operation signal of a conductivity probe from the controller.
- .4 Controller:
 - .1 Make/Model: As indicated or approved equal.
 - .2 Electric interlock with make-up water meter.
- .5 Water Meter:
 - .1 Materials
 - .1 Case: Stainless Steel.
 - .2 Internals: Engineered thermoplastic.
 - .3 Magnet: Alnico.

- .2 Physical Parameters
 - .1 Min. Flow rate: 0.25 USgpm.
 - .2 Max. Flow rate: 20 USgpm.
 - .3 Temperature: 35-122°F.
 - .4 Pressure: 150 psi.
- .3 Electrical
 - .1 Sensor: Dry contact reed switch.
 - .2 Max Voltage: 24V.
 - .3 Cable Length: to suit.
- .6 Chemical metering pump:
 - .1 General:
 - .1 Chemical metering pump to be positive displacement, diaphragm type pump. Output volume shall be adjustable while pump is in operation from zero to maximum capacity as indicated.
 - .2 Weight of pump as installed shall not exceed 6 pounds.
 - .3 Pump shall fit within a rectangular volume 8.4" long by 4.6" wide y 8.4" high.
 - .2 Drive:
 - .1 The pump mechanism shall be totally enclosed with no exposed moving parts.
 - .2 Electronic control module shall be easily removable for mounting in a remote location.
 - .3 Average power consumption shall not exceed 22 watts under full speed and maximum pressure conditions.
 - .4 Metering pump shall be capable of pumping a maximum of 1.5 GPH against a maximum pressure of 60 PSI.
 - .5 Pump speed shall be adjustable from 1 to 360 strokes per minute by means of a readily accessible keypad with digital display.
 - .3 Material:
 - .1 Pump housing shall be of chemically resistant glass fiber reinforced thermoplastic.
 - .2 All exposed fasteners shall be 316 stainless steel.
 - .3 Liquid end materials shall be as shown in Table 2.

Table 2

Liquid End	Pump Head & Fittings	Diaphragm	Valve Balls	Valve Seat	Valve Seals	Gasket	Tubing
FC	PVDF	PTFE bonded to EPDM	CE	PCTFE	PTFE	PTFE	PE
PC	GFRPP		CE	FKM	FKM		
PE	GFRPP		CE	EPDM	EPDM		
VC(A)	PVC		CE	FKM	FKM		
VE	PVC		CE	EPDM	EPDM		
TC	PVDF		CE	FKM	FKM		
VF	PVC		PTFE	EPDM	EPDM		
CE	Alumina ceramic		EPDM	Ethylene propylene diene monomer			
FKM	Fluoroelastomer		GFRPP	Glass fiber reinforced polypropylene			
PCTFE	Polychlorotrifluoroethylene		PE	Polyethylene			
PTFE	Polytetrafluoroethylene		PVC	Polyvinylchloride (translucent)			
PVDF	Polyvinylidene fluoride						

- .7 The multi-blend chemical to be utilized in the low pressure steam system to be a complete internal water treatment system for scale and corrosion control in condensate lines and the boiler; include a neutralizing amine to protect the condensate system from carbonic acid corrosion; include molybdate to ensure passivation of ferrous metal surfaces and prevent oxygen pitting; include a

		phosphate/alkaline program to treat against hardness and scale in the feedwater; and shall include a dispersant to reduce the deposition of particulate matter on heat transfer and equipment surfaces.
	.8	Solution to be pumped into boiler feed tank by chemical metering pump specified previously.
	.9	Provide a drop test kit containing all required equipment for P-Alkalinity, M-Alkalinity, Chlorides, Hardness, Phosphates, Sulfites, TDS and pH.
	.10	Recommended start-up dosage to be in accordance with feedrate as determined by water treatment system supplier.
	.11	Solution to arrive on site in sealed drums in liquid form. Contractor responsible to store the chemical in a cool, dry, well ventilated area.
	.12	Provide one (1) year supply of chemical as required for chemical treatment of the low pressure system piping and equipment.
2.4 CHEMICAL FEED PIPING	.1	Resistant to chemicals employed. Pressure rating: 1200 kPa.
2.5 SHIPPING/FEEDING CHEMICAL CONTAINERS	.1	High density moulded polyethylene, with liquid level graduations, cover.
2.8 CONDUCTIVITY PROBES	.1	Dual carbon elements in PVC holder, quick disconnect, self-locking connection.
2.7 CHEMICALS	.1	Obtain chemicals from manufacturer with existing valid contract with CSC.
2.8 TEST EQUIPMENT	.1	Provide one set of test equipment for each system to verify performance.
	.2	Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.
PART 3 - EXECUTION		
3.1 MANUFACTURER'S INSTRUCTIONS	.1	Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
3.2 INSTALLATION	.1	Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
	.2	Ensure adequate clearances to permit performance of servicing and maintenance of

equipment.

3.3 CHEMICAL FEED
PIPING

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 CLEANING OF
MECHANICAL SYSTEM

- .1 Provide copy of recommended cleaning procedures and chemicals for approval by CSC Representative.
- .2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.
- .3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
- .4 Drain and flush system until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.5 WATER TREATMENT
SERVICES

- .1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:
 - .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.

3.6 FIELD QUALITY
CONTROL

- .1 Start-up:
 - .1 Start up water treatment systems in accordance with manufacturer's instructions.
- .2 Commissioning:
 - .1 Commissioning Agency: to be installing water treatment sub-contractor.
 - .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After start-up and before TAB of connected systems.
 - .3 Pre-commissioning Inspections: verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of raw initial water analysis.
 - .4 Required quality of treated water.
 - .4 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
 - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
 - .3 Establish test intervals, regeneration intervals.
 - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water

analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.

.5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.

.6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).

.7 Advise Consultant in writing on matters regarding installed water treatment systems.

.5 Training:

.1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.

.6 Certificates:

.1 Upon completion, furnish certificates confirming satisfactory installation and performance.

.7 Commissioning Reports:

.1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Consultant.

.8 Commissioning activities during Warranty Period:

.1 Check out water treatment systems at the end of the Warranty Period and submit written report to Consultant.

3.7 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

- 1.1 SUMMARY .1 Section Includes:
- .1 Materials, accessories and installation for breechings, chimneys and stacks.
- 1.2 REFERENCES .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2 Underwriters' Laboratories of Canada (ULC)
 - .3 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.
 - .1 Submit copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit shop drawings.
 - .2 Indicate following:
 - .1 Methods of sealing sections.
 - .2 Methods of expansion.
 - .3 Details of thimbles.
 - .4 Bases/Foundations.
 - .5 Supports.
 - .6 Guy details.
 - .7 Rain caps.
 - .8 Roof flashing cones.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .4 Closeout Submittals
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY
ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.
- .2 Not used.
- .3 Certificates:
 - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.5 DELIVERY,
STORAGE, AND
HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

PART 2 - PRODUCTS

2.1 FUELS: PRESSURE
CHIMNEY AND
BREECHING

- .1 ULC labelled, 760 °C rated.
- .2 Sectional, prefabricated, double wall with air space, mineral wool insulation with mated fittings and couplings.
 - .1 Liner: 20 gauge thick, type 316 stainless steel, up to 900mm diameter; 1.2mm up to 1200mm.
 - .2 Shell: 34 gauge thick, type 316 stainless steel, up to 600mm diameter; 0.9mm up to 1200mm.
 - .3 Outer seals between sections: to suit application.
 - .4 Inner seals between sections: to suit application.
 - .5 Guy section and tensions where required.
 - .6 Storm collar and flashing for non-combustible roofs.
 - .7 Ventilated roof thimble and roof support assembly for combustible roofs.
 - .8 Stack cap.
 - .9 Lateral tee 45°, drain tee cap.
 - .10 Insulation Thickness: 25mm minimum.

2.2 ACCESSORIES

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: single acting, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA).
- .4 Rain cap.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.

- .6 Roof flashing cones.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION - GENERAL

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5 m centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.
- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.

3.3 CLEANING

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

PART 1 - GENERAL

1.1 REFERENCES

- .1 All codes, standards, etc. as referenced shall be the latest edition.
- .2 American National Standards Institute (ANSI)
 - .1 ANSI Z21.13/CSA 4.9, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .3 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV.
- .4 Canadian Gas Association (CGA)
 - .1 CAN1-3.1, Industrial and Commercial Gas-Fired Package Boilers.
 - .2 CAN/CSA-B149.1, Natural Gas and Propane Installation Code.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CSA B139, Installation Code for Oil Burning Equipment.
 - .3 CSA B140.7, Oil Burning Equipment: Steam and Hot-Water Boilers.
- .6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .8 Province of Ontario, O. Reg. 220/01: Boilers and Pressure Vessels

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.
 - .1 Submit copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 General arrangement showing terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
 - .3 Breeching and stack configuration.
 - .4 Piping hook-ups.
 - .5 Equipment electrical drawings.

	.6	Burners and controls.
	.7	All miscellaneous equipment.
	.8	Flame safety control system.
	.9	Breeching and stack configuration.
	.3	Engineering data to include:
	.1	Boiler efficiency at 33%, 66% and 100% of design capacity.
	.2	Radiant heat loss at 100% design capacity.
	.3	Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
	.1	Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
	.2	Instructions: submit manufacturer's installation instructions.
	.1	Departmental Representative CSC Representative Consultant will make available 1 copy of systems supplier's installation instructions.
	.4	Closeout Submittals:
	.1	Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
1.4 QUALITY ASSURANCE	.1	Regulatory Requirements: work to be performed in compliance with applicable Provincial regulations.
	.2	Health and Safety:
	.1	Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health, Safety and Emergency Response Procedures.
1.5 DELIVERY, STORAGE, AND HANDLING	.1	Packing, shipping, handling and unloading:
	.1	Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
1.6 MAINTENANCE	.1	Extra materials:
	.1	Special tools for burners, manholes, handholes and Operation and Maintenance.
	.2	Spare parts for 1 year of operation.
	.3	Spare gaskets.
	.4	Spare gauge glass inserts.
	.5	Probes and sealants for electronic indication.
	.6	Spare burner tips.
	.7	Spare burner gun.
	.8	Safety valve test gauge.

PART 2 - PRODUCTS

2.1 SUSTAINABLE
REQUIREMENTS

- .1 Not used.

2.2 PRODUCT

- .1 Acceptable boiler/burner manufacturer(s) include(s):
- .1 Weil-McLain or approved equal. Additional engineering design to accommodate an alternative will be at the contractor's expense.
 - .2 Other manufacturer(s) or other Weil-McLain boiler(s) must comply with specifying engineer's requirements, including:
 - .1 Full intent of these specifications, and provide complete submittal including literature, wiring diagrams, fuel piping diagrams, and a list of similar installations.
 - .3 Burner(s) and Energy Management Control System(s) must be tested and approved for installation with specified boiler by boiler manufacturer.
- .2 Boiler construction
- .1 Cast Iron sections
 - .2 Assembled with short, individual draw rods.
 - .3 Cast with sealing grooves for high temperature sealing rope to assure permanent gas-tight seal.
 - .4 Sealed watertight by elastomer sealing rings, not cast iron or steel nipples. Each port opening is machined to completely capture sealing ring between sections.
 - .5 Must be hydro-wall design to provide completely water-cooled combustion chamber.
 - .6 Provided with sufficient tapings to install required controls.
 - .7 Limited 10-year warranty against workmanship and defects to be in writing by manufacturer.
- .3 Boiler(s)
- .1 Boiler(s) to be designed with a (top) (rear) flue outlet.
 - .2 Provided with cast-in air elimination to separate air from circulating water.
 - .3 Provided with expansion tank tapping to divert separated air to expansion tank.
 - .4 Constructed to provide balanced water flow through entire section assembly using single supply and return connections for water. No external headers are necessary for water. Steam requires an external header 24" minimum from the waterline to the bottom of the header.
 - .5 Designed with a low silhouette to provide maximum headroom.
 - .6 Furnished with insulated burner mounting plate having necessary holes and tapings to mount burner. High temperature sealing rope is used to provide permanent gas-tight seal between front section and plate.
 - .7 Furnished with two observation ports (one in front and one in back) to allow visual inspection of the flame.
 - .8 Provided with steel flue damper assembly with a built-in adjustable damper capable of being locked into place after adjustment.
 - .9 Furnished with flanged aluminized steel flue collector hood bolted to top of section assembly.
 - .10 High temperature sealing rope used to provide permanent gas-tight seal between hood and section assembly.

- .11 Furnished with heavy-duty 1/4" steel cleanout plates to cover cleanout openings on the side of the boiler(s).
- .12 Port openings must be of captured seal design – a machined groove assures uniform compression of the sealing ring and protects the seal from contaminants. Elastomer sealing rings are to be used to provide permanent watertight seal between sections. Unlike cast iron or steel push nipples, the elasticity of the seals fills any gaps caused by misalignment or expansion and contraction.
- .13 Provided with flexible refractory blankets to be attached to back and floor of combustion chamber.
- .14 Shipped with insulated heavy gauge steel jacket(s) with durable powdered paint enamel finish. Jacket designed to be installed after connecting supply and return piping.
- .15 Jacket design will allow easy access to top and sides of boiler for maintenance and/or inspection without use of tools.
- .4 Boiler foundation(s):
 - .1 Installer to construct needed support and level concrete foundation(s) where boiler room floor is uneven or will not support the weight of the boiler(s).
- .5. Boiler trim:
 - .1 All electrical components to be of high quality and bear the U.L. label.
 - .2 Steam boiler(s) standard controls furnished:
 - .1 Low pressure (operating) and high pressure set at maximum pressure as a safety control.
 - .2 Steam pressure gauge with dial clearly marked and easy to read.
 - .3 Gauge cock water set with gauge glass, guards and aluminum water level plate.
 - .4 ASME certified pressure relief valve, set to relieve at 15 PSIG. Side outlet discharge type; contractor to pipe outlet to floor drain or near floor, avoiding any area where freezing could occur.
 - .3 Low water cut-off for water or steam boiler(s):
 - .1 Boiler(s) to be furnished with U.L. labeled low water cut-off with ASME working pressure rating equal to or exceeding the maximum boiler working pressure as shown on the boiler's rating label. Install cut-off according to manufacturer's instructions.
 - .2 Do not use quick-connect fittings on boiler(s).
 - .3 Locate so burner shuts down if boiler water level falls below allowable safe waterline (steam boilers, 1/4" above bottom of gauge glass).
 - .4 Steam boiler primary low water cut-off shall be a float type – auto reset.
 - .5 Steam boiler secondary low water cut-off shall be a float type or Probe-type with manual reset.
- .6 Burner(s)
 - .1 Burner fuel supply system and burner installation to conform to burner manufacturer's installation instructions and applicable codes.
 - .2 Burner motor characteristics: 120/1/60.
 - .3 Control characteristics 120/60/1.
 - .4 Burner fuel – natural gas (5.8 ") W.C. minimum.
 - .5 Code(s) - standard boiler.
 - .6 Burner(s) to have U.L. label(s) supplied by the burner manufacturer.
 - .7 Burner(s) designed to ensure high efficiency and good performance under forced draft conditions with 0.1" W.C. positive pressure at the flue collar.
 - .8 Burner(s) to be adjusted to provide 9.0 to 10.0% CO2 for natural gas.
 - .9 Burner(s) manufactured by: Power-Flame

- .10 Burner operating mode: low-high-loW.
 - .7. Panel options – power on/fuel on light is standard on all burner(s) with panels.
 - .1 Call For Heat
 - .2 Ignition On
 - .3 Pilot Failure
 - .4 Low Water
 - .5 Flame Failure
 - .6 Silencing Switch
 - .7 Control Fuse and Holder
 - .8 Post Purge Timer
 - .9 Alarm Bell
 - .10 Controls
 - .1 Refer to 1.3.B. of 23 09 23 Instrumentation and Control for HVAC.
 - 2.3 WARRANTY
 - .1 The package boiler shall be warranted for a period of one year from date of start-up or 18 months from shipment whichever shall occur first.
- PART 3 - EXECUTION
- 3.1 MANUFACTURER'S INSTRUCTIONS
 - .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
 - 3.2 INSTALLATION
 - .1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of the authority having jurisdiction, except where specified otherwise, and manufacturers recommendations.
 - .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
 - .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
 - .4 Mount unit level.
 - .5 Natural gas fired installations - in accordance with CAN/CSA-B149.1.
 - .6 Pipe steam relief valve through roof with drip pan elbow piped to nearest drain.
 - 3.3 MOUNTINGS AND ACCESSORIES
 - .1 Safety valves and relief valves:
 - .1 Run separate discharge from each valve.
 - .2 Terminate discharge pipe 150mm above finished floor.
 - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.
 - .2 Blowdown valves:

- .1 Run discharge to terminate as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Commissioning:
 - .1 Manufacturer to:
 - .1 Certify installation.
 - .2 Start up and commission installation.
 - .3 Carry out on-site performance verification tests.
 - .4 Demonstrate operation and maintenance.
 - .2 Provide CSC Representative at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.5 CLEANING

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

APPENDIX A

Hazardous Building Materials Assessment

443 Union Street West

Kingston, Ontario

Prepared for:

Correctional Services Canada

443 Union Street West

Kingston, Ontario, K7L 2R8



REVISED **Hazardous Building Materials Assessment**

443 Union Street West,
Kingston, Ontario

Prepared for:

Correctional Services Canada

443 Union Street West
Kingston, Ontario, K7L 2R8

Attention: Suzanne Ronan
Project Officer

July 27, 2017

Pinchin File: 206685



Hazardous Building Materials Assessment

443 Union Street West, Kingston, Ontario
Correctional Services Canada

July 27, 2017
Pinchin File: 206685
REVISED

Issued to: Correctional Services Canada
Contact: Suzanne Ronan
Project Officer
Issued on: July 27, 2017
Pinchin File: 206685
Issuing Office: 1456 Centennial Drive, Suite 2,
Kingston, ON, K7P 0K4
Primary Pinchin
Contact: Glenn Hendry, Project Manager
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EXECUTIVE SUMMARY

Correctional Services Canada (Client) retained Pinchin Ltd. (Pinchin) to conduct a hazardous building materials assessment at the building located at 443 Union Street West, Kingston, Ontario. Pinchin performed the assessment on June 28, 2017.

The objective of the assessment was to identify specified hazardous building materials in preparation for building renovation. The results of this assessment are intended for use with a properly developed scope of work and performance specification.

The assessed area the area of the building shown on the drawings in Appendix I.

SUMMARY OF FINDINGS

Asbestos: Asbestos-containing materials (ACM) were confirmed to be present as follows:

- Friable paring cement insulation, on pipe fittings in Boiler Room 1, in good condition; and
- Non-friable black caulking associated with the exterior stack of Boiler Room 2, in good condition.

Lead: Lead was confirmed present in select paints/surface coatings and is present in emergency light batteries and joints of cast-iron pipes.

Silica: Crystalline silica is present in concrete, mortar, brick, masonry, and plaster.

Mercury: Mercury vapour is present in fluorescent lamps and liquid mercury is present in thermostat ampules.

Polychlorinated Biphenyls (PCBs): PCBs may be present in fluorescent light ballasts.

SUMMARY OF RECOMMENDATIONS

The following is a summary of significant recommendations; refer to the body of the report for detailed recommendations:

1. Remove and properly dispose of asbestos-containing materials if disturbed by the planned renovation work;
2. Remove and properly dispose of PCB ballasts and mercury-containing items prior to if disturbed by the planned renovation work; and
3. Follow appropriate safe work procedures when handling or disturbing lead and silica.



Please refer to Section 4.0 of this report for detailed recommendations regarding administrative, renovation activities.

This Executive Summary is subject to the same standard limitations as contained in the report and must be read in conjunction with the entire report.



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APPENDIX II-B	Lead Analytical Certificates
APPENDIX II-C	PCB Analytical Certificates
APPENDIX III	Methodology



1.0 INTRODUCTION AND SCOPE

Correctional Services Canada (Client) retained Pinchin Ltd. (Pinchin) to conduct a hazardous building materials assessment at the building located at 443 Union Street West, Kingston, Ontario.

Michel Bernier performed the assessment on June 28, 2017. The surveyors were accompanied by a Commissionaire during the assessment. The building was occupied at the time of the assessment.

The objective of the assessment was to identify specified hazardous building materials in preparation for building renovation. This assessment is intended to be used for pre-construction purposes only, and may not provide sufficient detail for long term management of hazardous materials as required by Health and Safety regulations. The results of this assessment are intended for use with a properly developed scope of work and performance specification.

1.1 Scope of Assessment

The assessment was performed to establish the location and type of specified hazardous building materials incorporated in the structures and its finishes. The assessed area was limited to the parts of the building within the area to be renovated, which includes the following:

- Chimney Stacks;
- Boiler Room 1, located on the second floor;
- Boiler Room 2, located in the basement; and
- Two representative rooms from floors 1, 2 and 3.

The extent of the assessed area was defined by the Client and is shown on the appended drawings.

For the purpose of the assessment and this report, hazardous building materials are defined as follows:

- Asbestos;
- Lead;
- Silica;
- Mercury;
- Polychlorinated Biphenyls (PCBs); and
- Mould.



The following Ontario Designated Substances are not typically found in building materials in a composition/state that is hazardous and were not included in this assessment:

- Arsenic;
- Acrylonitrile;
- Benzene;
- Coke oven emissions;
- Ethylene oxide;
- Isocyanates; and
- Vinyl chloride monomer.

2.0 BACKGROUND INFORMATION

Building Description Item	Details
Building Use	Administrative Building
Assessed Area	3 stories plus 1 below grade
Year of Construction/Significant Additions/Renovations (area assessed)	Unknown
Structure	Structural steel, concrete
Exterior Cladding	Pre-cast concrete and brick masonry
HVAC	Rooftop AC, and boiler and hot water heating to radiators
Roof	Metal
Flooring in Assessed Areas	Vinyl tile, carpet, poured concrete
Interior Walls in Assessed Areas	Drywall, concrete block, plaster
Ceilings in Assessed Areas	Plaster, acoustic ceiling tiles, open plenum

3.0 FINDINGS

3.1 Asbestos

3.1.1 *Suspect Building Materials Not Found*

The following types of building materials may historically contain asbestos but were not observed in the assessed area and are not discussed in the report findings:

- Spray-applied fireproofing or thermal insulation;
- Texture finishes (acoustic/decorative);
- Acoustic ceiling tiles;
- Drywall joint compound;
- Asbestos cement products;
- Vinyl sheet flooring; and
- Vinyl floor tiles and mastic.

3.1.2 *Thermal Systems Insulation (TSI)*

3.1.2.1 *Pipe Insulation*

Parging cement, containing chrysotile asbestos, is present on pipe fittings (elbows, valves, tees, hangers etc.) on condensate and steam systems (samples 0002A-C and 0004A-C) in Boiler Room 1. Parging cement is a friable insulation, jacketed with canvas and is in good condition.

Non-asbestos insulation (e.g. fibreglass) is present on straight sections of pipes (samples 0001A-C and 0003A-C) in Boiler Room 1.



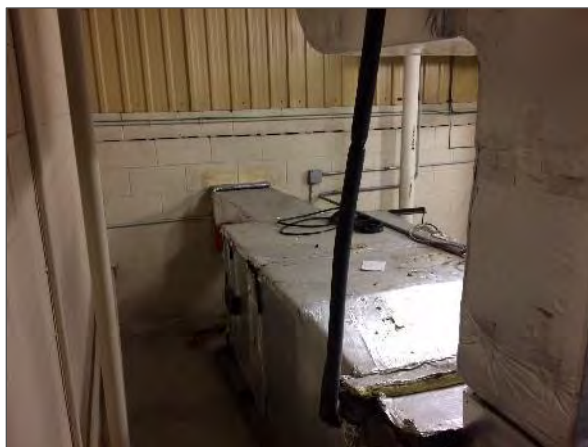
Asbestos containing parging cement pipe fittings (Samples 0004A-C) and non-asbestos fibreglass insulation (Samples 0003A-C) present in Boiler Room 1.



Asbestos containing parging cement pipe fittings (Samples 0002A-C) and non-asbestos fibreglass insulation (Samples 0001A-C) present in Boiler Room 1.

3.1.2.2 Duct Insulation

Ducts are either uninsulated or insulated with non-asbestos fibreglass and are jacketed with foil (Samples 0005A-C).



Duct insulated with fibreglass (Samples 0005A-C) in Boiler Room 1.

3.1.2.3 Mechanical Equipment Insulation

Mechanical equipment is either uninsulated or insulated with non-asbestos fibreglass.

3.1.3 Vermiculite

Destructive testing was conducted of masonry block walls. The masonry block walls were penetrated in several locations in Boiler Room 1 and 2, loose fill vermiculite was not observed. The locations of destructive testing have been indicated on the drawings in Appendix I.

3.1.4 Plaster

Plaster is present on the ceiling of Boiler Room 2 in the basement, perimeter and partition walls on the first, second and third floor. Plaster does not contain asbestos (samples 0008A-C, 0009A-B, and 0010A-B, and 0001A-G).

3.1.5 Sealants, Caulking, and Putty

Black caulking associated with the exterior stack of Boiler Room 2 contains chrysotile asbestos (samples 0007A-C). Caulking is non-friable and is in good condition.

The black caulking associated with the exterior stack of Boiler Room 1 does not contain asbestos (samples 0006A-C).

3.2 Lead

3.2.1 Paints and Surface Coatings

A total of three paint samples were collected from interior and exterior painted finishes. The following table summarizes the analytical results for paints sampled and their locations:

Sample Number	Colour, Substrate Description	Location	Lead (µg/g)
L001	Beige on drywall	Boiler Room 1	59
L002	Off white on drywall	Boiler Room 2	815
L003	Paint on caulking	Boiler Room 2	91

All paints were found to be in good condition and not flaking, peeling or delaminating.

3.2.2 Lead Products and Applications

Lead-containing batteries are present in emergency lighting.

Lead wool or lead caulking is present in bell and spigot fittings on cast iron pipes in the assessed area.



Lead acid battery for emergency lighting.

3.2.3 *Presumed Lead Materials*

Lead may be present in a number of materials which were not assessed and/or sampled. The following materials, where found, should be considered to contain lead:

- Electrical components, including wiring connectors, grounding conductors, and solder.

3.3 **Silica**

Crystalline silica is a presumed component of the following materials where present in the building:

- Poured or pre-cast concrete;
- Masonry and mortar; and
- Plaster.

3.4 **Mercury**

3.4.1 *Lamps*

Mercury vapour is present in fluorescent lamps.

3.4.2 *Mercury-Containing Devices*

Mercury is present as a liquid in thermostats found in the assessed area.



3.5 Polychlorinated Biphenyls

3.5.1 Caulking

Black caulking is present on exterior stacks associated with Boiler Room 1 and Boiler Room 2 (samples P01 and P02) and contains <5.68 and <15.6 µg/g PCBs, respectively. The material is a non-PCB solid based on the threshold given in SOR/2008-273 (50 µg/g).

3.5.2 Lighting Ballasts

The building has not been comprehensively re-lamped with new energy efficient light ballasts and lamps, and as such, a percentage of light ballasts will be pre-1980 and contain PCBs.

3.5.3 Transformers

Transformers were not found during the assessment.

3.6 Mould

Visible mould growth was not found during the assessment.

4.0 RECOMMENDATIONS

4.1 General

1. Provide this report to the contractor prior to bidding or commencing work;
2. Retain a qualified consultant to specify, inspect and verify the successful removal of hazardous materials; and
3. Update the asbestos inventory upon completion of the abatement and removal of asbestos-containing materials.

4.2 Building Renovation Work

The following recommendations are made regarding demolition or renovation involving the hazardous materials identified.

4.2.1 Asbestos

Remove asbestos-containing materials (ACM) prior to renovation, alteration, maintenance or demolition work if ACM may be disturbed by the work.

If the identified ACM will not be removed prior to commencement of the work, disturbance of ACM must follow the appropriate asbestos precautions for the classification of work being performed.



Asbestos-containing materials must be disposed of at a landfill approved to accept asbestos waste.

4.2.2 Lead

Construction disturbance of lead in paint and coatings (or other materials) may result in over-exposure to lead dust or fumes. The need for work procedures, engineering controls and personal protective equipment will need to be assessed on a project-by-project basis and must comply with provincial standards or guidelines.

Lead-containing items should be recycled when taken out of service.

4.2.3 Silica

Construction disturbance of silica-containing products may result in excessive exposures to airborne silica, especially if performed indoors and dry. Cutting, grinding, drilling or demolition of materials containing silica should be completed only with proper respiratory protection and other worker safety precautions that comply with provincial standards or guidelines.

4.2.4 Mercury

Do not break lamps or separate liquid mercury from components. Recycle and reclaim mercury from fluorescent lamps and thermostats when taken out of service. Liquid mercury is classified as a hazardous waste and must be disposed of in accordance with local regulations.

4.2.5 PCBs

When light fixtures are removed, examine light ballasts for PCB content. If ballasts are not clearly labelled as "non-PCB", or are suspected to contain PCBs; package and ship ballasts for destruction at a federally permitted facility.

5.0 TERMS AND LIMITATIONS

This work was performed subject to the Terms and Limitations presented or referenced in the proposal for this project.

Information provided by Pinchin is intended for Client use only. Pinchin will not provide results or information to any party unless disclosure by Pinchin is required by law. Any use by a third party of reports or documents authored by Pinchin or any reliance by a third party on or decisions made by a third party based on the findings described in said documents, is the sole responsibility of such third parties. Pinchin accepts no responsibility for damages suffered by any third party as a result of decisions made or actions conducted. No other warranties are implied or expressed.



6.0 REFERENCES

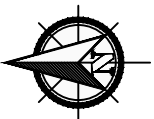
The following legislation and documents were referenced in completing the assessment and this report:

1. Asbestos on Construction Projects and in Buildings and Repair Operations, Ontario Regulation 278/05.
2. Designated Substances, Ontario Regulation 490/09.
3. Lead on Construction Projects, Ministry of Labour Guidance Document.
4. Ministry of the Environment Regulation, R.R.O. 1990 Reg. 347 as amended.
5. Surface Coating Materials Regulations, SOR/2005-109, Hazardous Products Act.
6. Silica on Construction Projects, Ministry of Labour Guidance Document.
7. Alert – Mould in Workplace Buildings, Ontario Ministry of Labour.

206685 Haz Mat Report Boiler Reno 443 Union W KGN On CSC Revised.docx

Template: Master Report for Hazardous Materials Assessment Report (Pre-Construction), Haz, January 16, 2017

APPENDIX I
Drawings



- LEGEND:
- ASSESSED AREA
 - ASBESTOS BULK SAMPLE
 - LEAD BULK SAMPLE
 - PCB BULK SAMPLE
 - PENETRATION CUT FOR VERMICULITE

NOT ALL KNOWN OR SUSPECTED HAZARDOUS BUILDING MATERIALS MAY BE DEPICTED ON THE DRAWING. REFER TO THE HAZARDOUS BUILDING MATERIALS ASSESSMENT REPORT FOR A COMPLETE LIST OF KNOWN AND SUSPECTED HAZARDOUS BUILDING MATERIALS.

LEGEND IS COLOUR DEPENDENT. NON-COLOUR COPIES MAY ALTER INTERPRETATION.

BASE PLAN PROVIDED BY CLIENT.

CLIENT:
CORRECTIONAL SERVICE
CANADA

LOCATION:
443 UNION STREET WEST
KINGSTON, ONTARIO

TITLE:
HAZARDOUS BUILDING
MATERIALS ASSESSMENT
BASEMENT

DATE:
2017/07/20

PROJECT # :
206685

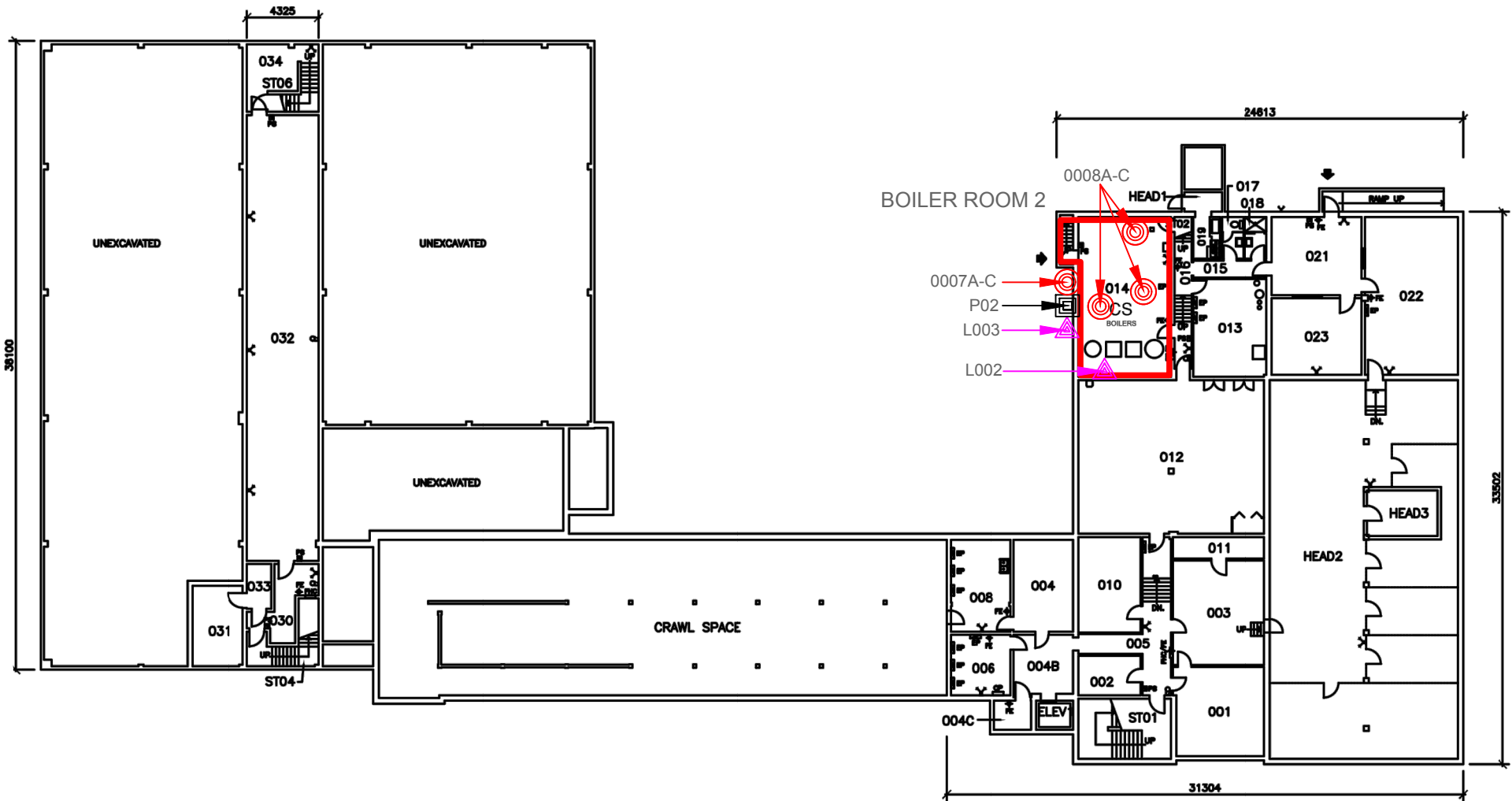
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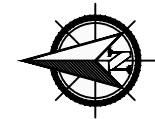
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MB

SCALE:
NTS

1 OF 3



- NOTES:
- FRIABLE PARGING CEMENT INSULATION, CONTAINING CHRYSOTILE ASBESTOS, IS PRESENT IN BOILER ROOM 2.
 - NON-FRIABLE BLACK CAULKING, CONTAINING CHRYSOTILE ASBESTOS, IS PRESENT ON CHIMNEY ASSOCIATED WITH BOILER ROOM 2.



LEGEND:

- ASSESSED AREA
- ASBESTOS BULK SAMPLE
- LEAD BULK SAMPLE
- PCB BULK SAMPLE
- PENETRATION CUT FOR VERMICULITE

NOT ALL KNOWN OR SUSPECTED HAZARDOUS BUILDING MATERIALS MAY BE DEPICTED ON THE DRAWING. REFER TO THE HAZARDOUS BUILDING MATERIALS ASSESSMENT REPORT FOR A COMPLETE LIST OF KNOWN AND SUSPECTED HAZARDOUS BUILDING MATERIALS.

LEGEND IS COLOUR DEPENDENT. NON-COLOUR COPIES MAY ALTER INTERPRETATION.

BASE PLAN PROVIDED BY CLIENT.

CLIENT:
CORRECTIONAL SERVICE
CANADA

LOCATION:
443 UNION STREET WEST
KINGSTON, ONTARIO

TITLE:
HAZARDOUS BUILDING
MATERIALS ASSESSMENT
GROUND FLOOR

DATE:
2017/07/20

PROJECT # :
206685

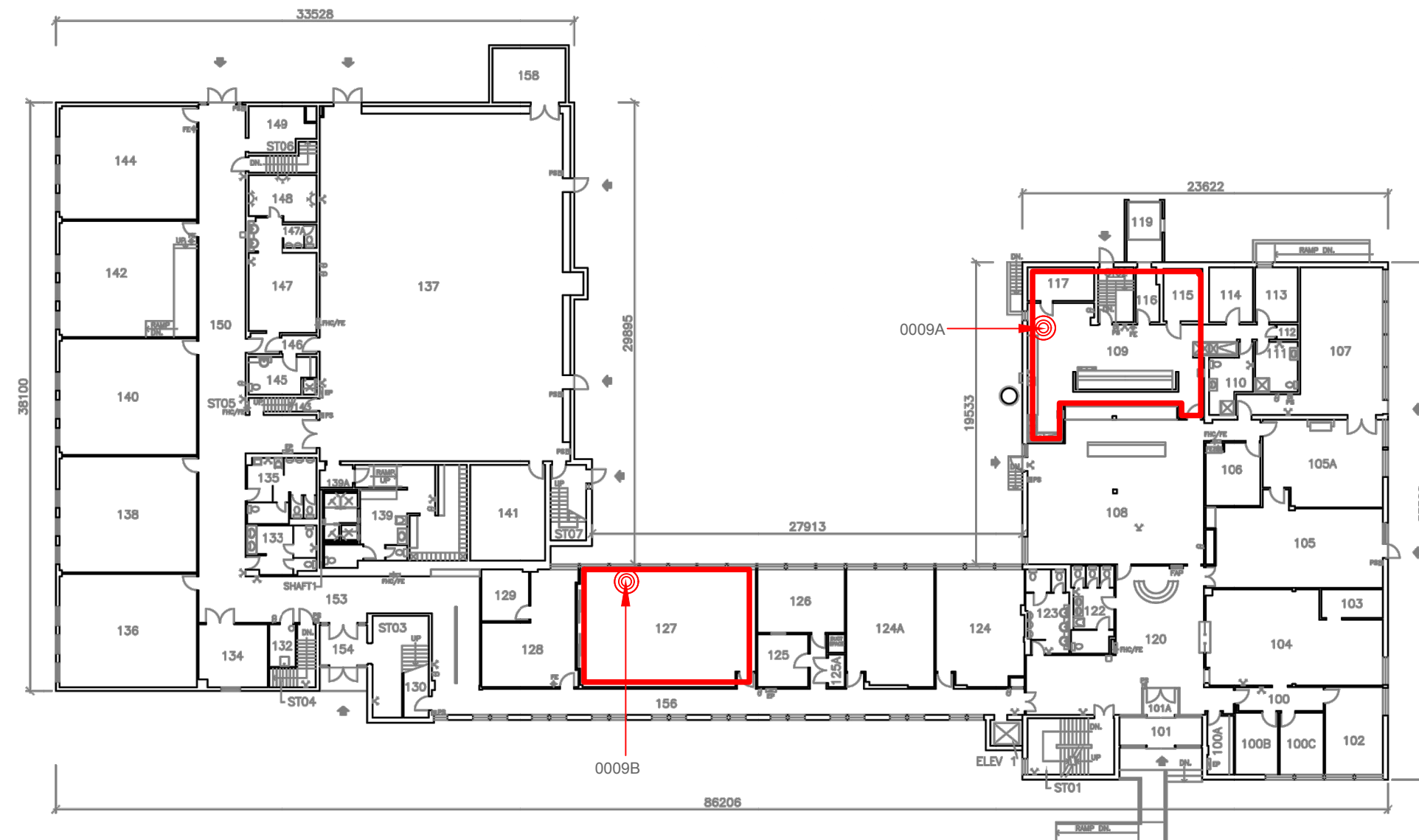
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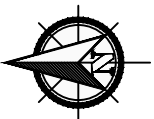
DRAWING:

CHECKED BY:
MB

2 OF 3

SCALE:
NTS





- LEGEND:
- ASSESSED AREA
 - ASBESTOS BULK SAMPLE
 - LEAD BULK SAMPLE
 - PCB BULK SAMPLE
 - PENETRATION CUT FOR VERMICULITE

NOT ALL KNOWN OR SUSPECTED HAZARDOUS BUILDING MATERIALS MAY BE DEPICTED ON THE DRAWING. REFER TO THE HAZARDOUS BUILDING MATERIALS ASSESSMENT REPORT FOR A COMPLETE LIST OF KNOWN AND SUSPECTED HAZARDOUS BUILDING MATERIALS.

LEGEND IS COLOUR DEPENDENT. NON-COLOUR COPIES MAY ALTER INTERPRETATION.

BASE PLAN PROVIDED BY CLIENT.

CLIENT:
CORRECTIONAL SERVICE
CANADA

LOCATION:
443 UNION STREET WEST
KINGSTON, ONTARIO

TITLE:
HAZARDOUS BUILDING
MATERIALS ASSESSMENT
SECOND FLOOR

DATE:
2017/07/20

PROJECT # :
206685

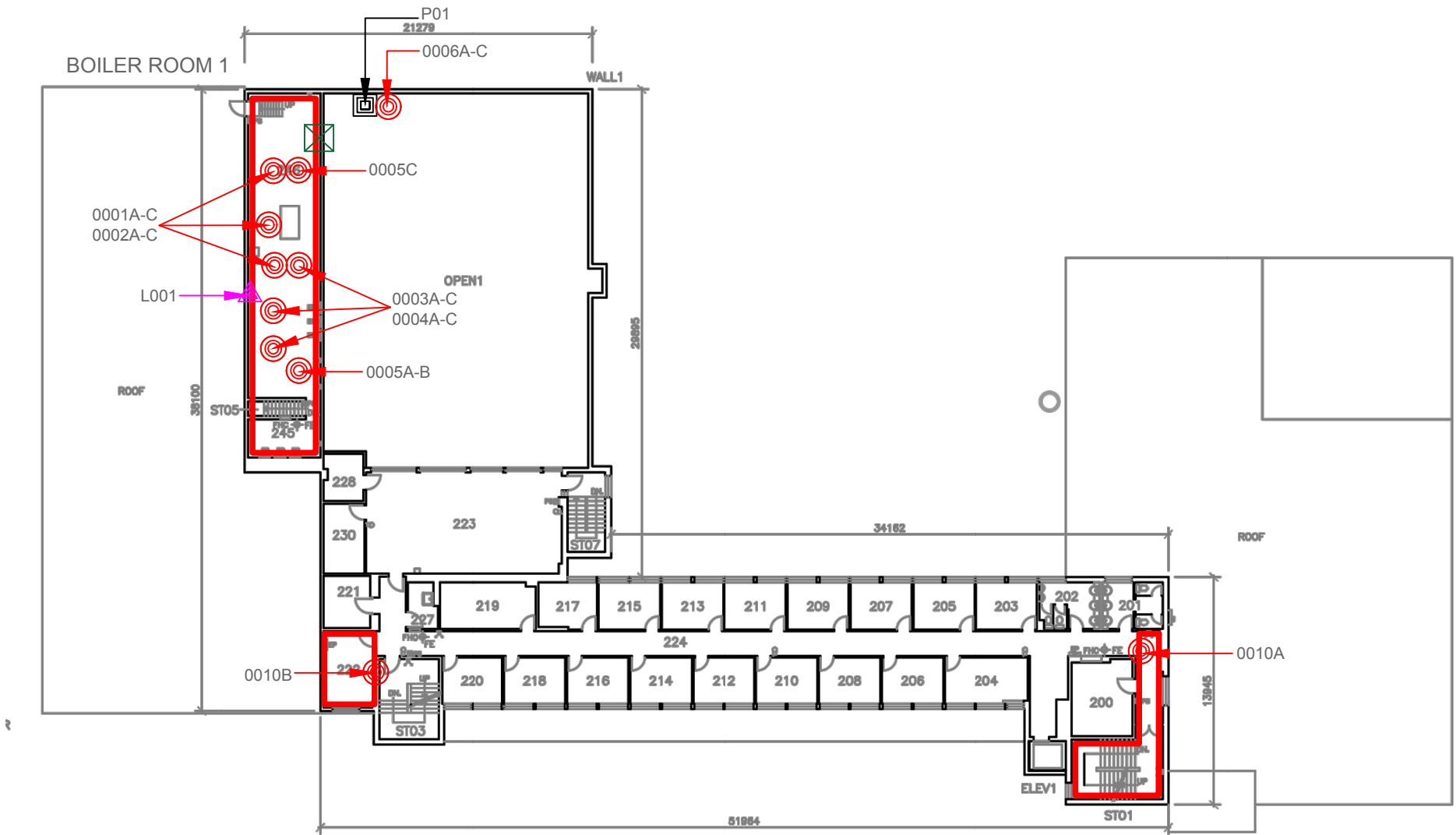
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MH

DRAWING:

CHECKED BY:
MB

SCALE:
NTS

3 OF 3



NOTES:
1. FRIABLE PARGING CEMENT INSULATION, CONTAINING CHRYSOTILE ASBESTOS, IS PRESENT IN BOILER ROOM 1.

APPENDIX II-A
Asbestos Analytical Certificates



Pinchin Ltd. Asbestos Laboratory *Certificate of Analysis*

Project Name: Correctional Service Canada , 442 Union Street West, Kingston Ontario
Project No.: 0206685.000
Prepared For: M. Bernier / G. Hendry Date Received: June 30, 2017
Lab Reference No.: b172676 Date Analyzed: July 10, 2017
Analyst(s): T. Tran # Samples submitted: 28
Phases analyzed: 28

Method of Analysis:

EPA 600/R-93/116 - Method for the Determination of Asbestos in Bulk Building Materials dated July, 1993

Bulk samples are checked visually and scanned under a stereomicroscope. Slides are prepared and observed under a Polarized Light Microscope (PLM) at magnifications of 40X, 100X or 400X as appropriate. Asbestos fibres are identified by a combination of morphology, colour, refractive index, extinction, sign of elongation, birefringence and dispersion staining colours. A visual estimate is made of the percentage of asbestos present. A reported concentration of less than (<) the regulatory threshold (see chart below) indicates the presence of confirmed asbestos in trace quantities, limited to only a few fibres or fibre bundles in an entire sample. This method complies with provincial regulatory requirements where applicable. Multiple phases within a sample are analyzed and reported separately.

Provincial Jurisdiction	Regulatory Threshold	Provincial Jurisdiction	Regulatory Threshold
Ontario, British Columbia, Nova Scotia	0.5%	Manitoba	0.1% friable 1% non-friable
Quebec	0.1%	Saskatchewan	0.5% friable 1% non-friable
Alberta, NWT, Yukon, Nunavut	1%	Newfoundland and Labrador, PEI and New Brunswick	1%

All bulk samples submitted to this laboratory for asbestos analysis are retained for a minimum of three months. Samples may be retrieved, upon request, for re-examination at any time during that period.

Pinchin Ltd. is accredited by the National Institute of Standards and Technology, National Voluntary Laboratory Accreditation Program (NVLAP Lab Code 101270-0) for the 'EPA-600/M4-82-020: Interim Method for the Determination of Asbestos in Bulk Insulation Samples,' and the 'EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials'; and meets all requirements of ISO/IEC 17025:2005.

This report relates only to the items tested.

NOTE: This test report may not be reproduced, except in full, without the written approval of the laboratory. The client may not use this report to claim product endorsement by NVLAP or any agency of the U.S. Government. This report is valid only when signed in blue ink by the analyst. Vinyl asbestos floor tiles contain very fine fibres of asbestos and may be missed by some laboratories using the PLM method. Internal verification studies performed by Pinchin indicate that the chance of missing asbestos in floor tiles is no higher than about 2%. The vinyl tile study and laboratory documentation on measurement uncertainty is available upon request. The analysis of dust samples by PLM cannot be used as an indicator of past or present airborne asbestos fibre levels.



Pinchin Ltd. Asbestos Laboratory Certificate of Analysis

Project Name: Correctional Service Canada , 442 Union Street West, Kingston Ontario
Project No.: 0206685.000
Prepared For: M. Bernier / G. Hendry

Lab Reference No.: b172676
Date Analyzed: July 10, 2017

BULK SAMPLE ANALYSIS

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0001A Pipe insulation straight, boiler room 1, LF STEAM	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous Fibres > 75% Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0001B Pipe insulation straight, boiler room 1, LF STEAM	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous Fibres > 75%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0001C Pipe insulation straight, boiler room 1, LF STEAM	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous Fibres > 75% Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0002A Pipe insulation elbow, boiler room 1, LF STEAM	Homogeneous, grey, soft, parging cement.	Chrysotile 50-75%	Non-Fibrous Material 25-50%
Comments:	Man-made vitreous fibres and cotton fabric reinforcement are present on the surface of this sample.		
0002B Pipe insulation elbow, boiler room 1, LF STEAM			Not Analyzed
Comments:	Analysis was stopped due to a previous positive result.		
0002C Pipe insulation elbow, boiler room 1, LF STEAM			Not Analyzed
Comments:	Analysis was stopped due to a previous positive result.		



Pinchin Ltd. Asbestos Laboratory Certificate of Analysis

Project Name: Correctional Service Canada , 442 Union Street West, Kingston Ontario
Project No.: 0206685.000
Prepared For: M. Bernier / G. Hendry

Lab Reference No.: b172676
Date Analyzed: July 10, 2017

BULK SAMPLE ANALYSIS

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0003A Pipe insulation straight, boiler room 1, CONDENSATE	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous > 75% Fibres Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0003B Pipe insulation straight, boiler room 1, CONDENSATE	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous > 75% Fibres Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0003C Pipe insulation straight, boiler room 1, CONDENSATE	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous > 75% Fibres Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0004A Pipe insulation elbow, boiler room 1, CONDENSATE	Homogeneous, grey, soft, parging cement.	Chrysotile 50-75%	Non-Fibrous Material 25-50%
Comments:	Man-made vitreous fibres and cotton fabric reinforcement are present on the surface of this sample.		
0004B Pipe insulation elbow, boiler room 1, CONDENSATE			Not Analyzed
Comments:	Analysis was stopped due to a previous positive result.		
0004C Pipe insulation elbow, boiler room 1, CONDENSATE			Not Analyzed
Comments:	Analysis was stopped due to a previous positive result.		



Pinchin Ltd. Asbestos Laboratory Certificate of Analysis

Project Name: Correctional Service Canada , 442 Union Street West, Kingston Ontario
Project No.: 0206685.000
Prepared For: M. Bernier / G. Hendry

Lab Reference No.: b172676
Date Analyzed: July 10, 2017

BULK SAMPLE ANALYSIS

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0005A Duct insulation, boiler room 1, east portion	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous Fibres > 75% Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0005B Duct insulation, boiler room 1, west portion	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous Fibres > 75% Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0005C Duct insulation, boiler room 1, central portion	Homogeneous, yellow, fibrous material.	None Detected	Man-made Vitreous Fibres > 75% Non-Fibrous Material 0.5-5%
Comments:	Cotton fabric reinforcement, foil and cellulose are present on the surface of this sample.		
0006A Caulking, boiler room 1, exterior stack	2 Phases: a) Homogeneous, grey, caulking material.	None Detected	Non-Fibrous Material > 75%
	b) Homogeneous, black, tar material with fibres.	None Detected	Cellulose 25-50% Tar and other non-fibrous 50-75%
Comments:	Phase b) is small in size.		
0006B Caulking, boiler room 1, exterior stack	2 Phases: a) Homogeneous, grey, caulking material.	None Detected	Non-Fibrous Material > 75%
	b) Homogeneous, black, tar material with fibres.	None Detected	Cellulose 10-25% Tar and other non-fibrous > 75%
Comments:	Phase b) is small in size. For more reliable results, a larger sample is required.		



Pinchin Ltd. Asbestos Laboratory Certificate of Analysis

Project Name: Correctional Service Canada , 442 Union Street West, Kingston Ontario
Project No.: 0206685.000
Prepared For: M. Bernier / G. Hendry

Lab Reference No.: b172676
Date Analyzed: July 10, 2017

BULK SAMPLE ANALYSIS

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0006C Caulking, boiler room 1, exterior stack	Homogeneous, grey, caulking material.	None Detected	Non-Fibrous Material > 75%
0007A Caulking, boiler room 2, exterior stack	Homogeneous, black, caulking material.	Chrysotile 10-25%	Man-made Vitreous Fibres 0.5-5% Tar and other non-fibrous > 75%
0007B Caulking, boiler room 2, exterior stack			Not Analyzed
Comments:	Analysis was stopped due to a previous positive result.		
0007C Caulking, boiler room 2, exterior stack			Not Analyzed
Comments:	Analysis was stopped due to a previous positive result.		
0008A Plaster finish on cement, boiler room 2, ceiling	Homogeneous, grey, hard, cementitious, plaster base coat.	None Detected	Perlite 10-25% Other Non-Fibrous > 75%
0008B Plaster finish on cement, boiler room 2, ceiling	Homogeneous, grey, hard, cementitious, plaster base coat.	None Detected	Perlite 10-25% Other Non-Fibrous > 75%
0008C Plaster finish on cement, boiler room 2, ceiling	Homogeneous, grey, hard, cementitious, plaster base coat.	None Detected	Perlite 10-25% Other Non-Fibrous > 75%
0009A Plaster finish, main floor, cafeteria	Homogeneous, white, hard, cementitious, plaster top coat.	None Detected	Non-Fibrous Material > 75%



Pinchin Ltd. Asbestos Laboratory Certificate of Analysis

Project Name: Correctional Service Canada , 442 Union Street West, Kingston Ontario
Project No.: 0206685.000
Prepared For: M. Bernier / G. Hendry

Lab Reference No.: b172676
Date Analyzed: July 10, 2017

BULK SAMPLE ANALYSIS

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0009B Plaster finish, main floor, Grand Valley Room	3 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat. b) Homogeneous, white, hard, cementitious, plaster top coat. c) Homogeneous, white, layered, drywall joint compound.	None Detected	Hair 0.5-5% Non-Fibrous Material > 75%
0010A Plaster finish, second floor, near north exit	2 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat. b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected	Hair 0.5-5% Non-Fibrous Material > 75%
0010B Plaster finish, second floor, room 222	2 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat. b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected	Hair 0.5-5% Non-Fibrous Material > 75%

Reviewed by:


Digitally signed
by Julieth Oran
Date: 2017.07.10
14:50:42 -04'00'

Reporting Analyst:


Digitally signed
by Julieth Oran
Date: 2017.07.10
14:50:29 -04'00'

Analyzed by: *TH*Reviewed by: *HC*Report Sent by: *JR*

✓

Pinchin Ltd. - Asbestos Laboratory Internal Asbestos Bulk Sample Chain of Custody

Client Name:	Correctional Service Canada	Project Address:	442 Union Street West, Kingston Ontario
Portfolio/Building No:		Pinchin File:	206685
Submitted by:	Michel Bernier	Email:	mbernier@pinchin.com
CC Results to:	Glenn Hendry	CC Email:	ghendry@pinchin.com
Date Submitted:	June 28 2017	Required by:	July 5 2017
# of Samples:	28	Priority:	5 Day Turnaround
Year of Building Construction (Mandatory, Years ONLY):	1930		
Do NOT Stop on Positive (Sample Numbers):			
Pinchin Group Company (Mandatory Field):	Pinchin		

To be Completed by Lab Personnel Only:						
Lab Reference #:	<i>D172676</i>		Time:	24 hour clock		
Received by:	<i>JUN 30 2017 JR</i>		Date:	Month	Day	Year
Name(s) of Analyst(s):	<i>than</i>		<i>July 10 2017</i>			
Sample Prefix	Sample No.	Sample Suffix	Sample Description/Location (Mandatory)			
	0001	A	Pipe insulation straight, boiler room 1, LF STEAM	ND		
	0001	B	Pipe insulation straight, boiler room 1, LF STEAM	ND		
	0001	C	Pipe insulation straight, boiler room 1, LF STEAM	ND		
	0002	A	Pipe insulation elbow, boiler room 1, LF STEAM	CH 50-75		
	0002	B	Pipe insulation elbow, boiler room 1, LF STEAM	NA		
	0002	C	Pipe insulation elbow, boiler room 1, LF STEAM	NA		
	0003	A	Pipe insulation straight, boiler room 1, CONDENSATE	ND		

(5)

Sample Prefix	Sample No.	Sample Suffix	Sample Description/Location (Mandatory)
	0003	B	Pipe insulation straight, boiler room 1, CONDENSATE ND.
	0003	C	Pipe insulation straight, boiler room 1, CONDENSATE ND
	0004	A	Pipe insulation elbow, boiler room 1, CONDENSATE CH 50-75
	0004	B	Pipe insulation elbow, boiler room 1, CONDENSATE NA
	0004	C	Pipe insulation elbow, boiler room 1, CONDENSATE NA
	0005	A	Duct insulation, boiler room 1, east portion ND
	0005	B	Duct insulation, boiler room 1, west portion ND
	0005	C	Duct insulation, boiler room 1, central portion ND.
	0006	A	Caulking, boiler room 1, exterior stack A) ND B) ND
	0006	B	Caulking, boiler room 1, exterior stack A) ND B) ND
	0006	C	Caulking, boiler room 1, exterior stack ND.
	0007	A	Caulking, boiler room 2, exterior stack CH 10-25
	0007	B	Caulking, boiler room 2, exterior stack NA
	0007	C	Caulking, boiler room 2, exterior stack NA
	0008	A	Plaster finish on cement, boiler room 2, ceiling ND

Sample Prefix	Sample No.	Sample Suffix	Sample Description/Location (Mandatory)
	0008	B	Plaster finish on cement, boiler room 2, ceiling ND
	0008	C	Plaster finish on cement, boiler room 2, ceiling ND.
	0009**	A	Plaster finish, main floor, cafeteria ND
	0009**	B	Plaster finish, main floor, Grand Valley Room A) ND B) ND C) ND.
	0010**	A	Plaster finish, second floor, near north exit A) ND B) ND
	0010**	B	Plaster finish, second floor, room 222 A) ND B) ND.
** Scope of work specified 2 samples			

10



Pinchin Ltd. Asbestos Laboratory Certificate of Analysis

Project Name:	Correction Services Canada, Staff College, 443 Union Street, Kingston		
Project No.:	103140		
Prepared For:	Glenn Hendry	Date Received:	March 11, 2015
Lab Reference No.:	b117370	Date Analyzed:	March 11, 2015
Analyst(s):	A. Williams	# Samples submitted:	7
		# Phases analyzed:	16

Method of Analysis:

EPA 600/R-93/116 - Method for the Determination of Asbestos in Bulk Building Materials dated July, 1993

Bulk samples are checked visually and scanned under a stereomicroscope. Slides are prepared and observed under a Polarized Light Microscope (PLM) at magnifications of 40X, 100X or 400X as appropriate. Asbestos fibres are identified by a combination of morphology, colour, refractive index, extinction, sign of elongation, birefringence and dispersion staining colours. A visual estimate is made of the percentage of asbestos present. A reported concentration of less than (<) the regulatory threshold (see chart below) indicates the presence of confirmed asbestos in trace quantities, limited to only a few fibres or fibre bundles in an entire sample. This method complies with provincial regulatory requirements where applicable. Multiple phases within a sample are analyzed and reported separately.

Provincial Jurisdiction	Regulatory Threshold	Provincial Jurisdiction	Regulatory Threshold
Ontario, British Columbia, Nova Scotia	0.5%	Manitoba	0.1% friable 1% non-friable
Quebec	0.1%	Saskatchewan	0.5% friable 1% non-friable
Alberta, NWT, Yukon, Nunavut	1%	Newfoundland and Labrador, PEI and New Brunswick	1%

All bulk samples submitted to this laboratory for asbestos analysis are retained for a minimum of three months. Samples may be retrieved, upon request, for re-examination at any time during that period.

Pinchin Ltd. is accredited by the National Institute of Standards and Technology, National Voluntary Laboratory Accreditation Program (NVLAP Lab Code 101270-0) for the 'EPA-600/M4-82-020: Interim Method for the Determination of Asbestos in Bulk Insulation Samples' and meets all requirements of ISO/IEC 17025:2005.

This report relates only to the items tested.

NOTE: This test report may not be reproduced, except in full, without the written approval of the laboratory. The client may not use this report to claim product endorsement by NVLAP or any agency of the U.S. Government. This report is valid only when signed in blue ink by the analyst. Vinyl asbestos floor tiles contain very fine fibres of asbestos and may be missed by some laboratories using the PLM method. Internal verification studies performed by Pinchin indicate that the chance of missing asbestos in floor tiles is no higher than about 2%. The vinyl tile study and laboratory documentation on measurement uncertainty is available upon request. The analysis of dust samples by PLM cannot be used as an indicator of past or present airborne asbestos fibre levels.



Project Name: Correction Services Canada, Staff College, 443 Union Street, Kingston
Project No.: 103140
Prepared For: Glenn Hendry

Lab Reference No.: b117370
Date Analyzed: March 11, 2015

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0001A Plaster Wall, Room 320, Third Floor Staff College	2 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat. b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected None Detected	Non-Fibrous Material > 75% Non-Fibrous Material > 75%
0001B Plaster Wall, Room 306, Third Floor Staff College	3 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat. b) Homogeneous, white, hard, cementitious, plaster top coat. c) Homogeneous, white, drywall joint compound.	None Detected None Detected None Detected	Non-Fibrous Material > 75% Non-Fibrous Material > 75% Non-Fibrous Material > 75%
Comments:	Phase c) is small in size.		
0001C Plaster Wall, Room 311, Third Floor Staff College	2 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat. b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected None Detected	Non-Fibrous Material > 75% Non-Fibrous Material > 75%

K. Rostangj

Williams



Pinchin Ltd. Asbestos Laboratory
Certificate of Analysis

Project Name: Correction Services Canada, Staff College, 443 Union Street, Kingston
Project No.: 103140
Prepared For: Glenn Hendry

Lab Reference No.: b117370
Date Analyzed: March 11, 2015

BULK SAMPLE ANALYSIS

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0001D Plaster Wall, Room 312, Third Floor Staff College	2 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat.	None Detected	Non-Fibrous Material > 75%
	b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected	Non-Fibrous Material > 75%
Comments:	Phase a) is small in size. For more reliable results, a larger sample is required.		
0001E Plaster Wall, Room 315, Third Floor Staff College	2 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat.	None Detected	Non-Fibrous Material > 75%
	b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected	Non-Fibrous Material > 75%
0001F Plaster Wall, Corridor Ceiling at Room 314, Third Floor Staff College	3 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat.	None Detected	Perlite 10-25% Other Non-Fibrous > 75%
	b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected	Non-Fibrous Material > 75%
	c) Homogeneous, white, drywall joint compound.	None Detected	Non-Fibrous Material > 75%

REVIEWED BY

ANALYST



Pinchin Ltd. Asbestos Laboratory
Certificate of Analysis

Project Name: Correction Services Canada, Staff College, 443 Union Street, Kingston
Project No.: 103140
Prepared For: Glenn Hendry

Lab Reference No.: b117370
Date Analyzed: March 11, 2015

BULK SAMPLE ANALYSIS

SAMPLE IDENTIFICATION	SAMPLE DESCRIPTION	% COMPOSITION (VISUAL ESTIMATE)	
		ASBESTOS	OTHER
0001G Plaster Wall, Corridor Ceiling at Room 308, Third Floor Staff College	2 Phases: a) Homogeneous, grey, hard, cementitious, plaster base coat.	None Detected	Perlite 10-25% Other Non-Fibrous > 75%
	b) Homogeneous, white, hard, cementitious, plaster top coat.	None Detected	Non-Fibrous Material > 75%

REVIEWED BY

ANALYST

APPENDIX II-B
Lead Analytical Certificates

Certificate of Analysis

Pinchin Ltd. (Kingston)

1456 Centennial Drive, Suite 2
Kingston, ON K7P 0K4
Attn: Michel Bernier

Client PO:
Project: 206685.000
Custody:

Report Date: 6-Jul-2017
Order Date: 29-Jun-2017

Order #: 1726369

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
------------	-----------

1726369-01	L001 - Beige paint on partition wall, boiler room 1
1726369-02	L002 - Off white paint on perimeter wall, boiler room 2
1726369-03	L003 - Paint on Caulking, boiler room 2, exterior stack

Approved By:



Dale Robertson, BSc
Laboratory Director

Any use of these results implies your agreement that our total liability in connection with this work, however arising shall be limited to the amount paid by you for this work, and that our employees or agents shall not under circumstances be liable to you in connection with this work

Certificate of Analysis
Client: Pinchin Ltd. (Kingston)
Client PO:

Report Date: 06-Jul-2017
Order Date: 29-Jun-2017
Project Description: 206685.000

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Metals, ICP-OES	based on MOE E3470, ICP-OES	4-Jul-17	5-Jul-17

Sample and QC Qualifiers Notes

- 1- Gen-19 :Complete separation of paint from substrate not possible for this sample and a small amount of substrate has been included in the paint digestion.

Sample Data Revisions

None

Work Order Revisions/Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Certificate of Analysis
 Client: Pinchin Ltd. (Kingston)
 Client PO:

Report Date: 06-Jul-2017
 Order Date: 29-Jun-2017
 Project Description: 206685.000

Sample Results

Lead				Matrix: Paint
				Sample Date: 28-Jun-17
Paracel ID	Client ID	Units	MDL	Result
1726369-01	L001 - Beige paint on partition wall, boiler room 1	ug/g	20	59 [1]
1726369-02	L002 - Off white paint on perimeter wall, boiler room 2	ug/g	20	815
1726369-03	L003 - Paint on Caulking, boiler room 2, exterior stack	ug/g	20	91

Laboratory Internal QA/QC

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Matrix Blank									
Lead	ND	20	ug/g						
Matrix Spike									
Lead	263		ug/L		105	70-130			

APPENDIX II-C
PCB Analytical Certificates

Certificate of Analysis

Pinchin Ltd. (Kingston)

1456 Centennial Drive, Suite 2
Kingston, ON K7P 0K4
Attn: Michel Bernier

Client PO:
Project: 206685.000
Custody:

Report Date: 6-Jul-2017
Order Date: 29-Jun-2017

Order #: 1726478

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1726478-01	P01 - Caulking, boiler room 1, exterior stack
1726478-02	P02 - Caulking, boiler room 2, exterior stack

Approved By:



Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
Client: Pinchin Ltd. (Kingston)
Client PO:

Report Date: 06-Jul-2017

Order Date: 29-Jun-2017

Project Description: 206685.000

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
PCBs, total	SW846 8082A - GC-ECD	5-Jul-17	6-Jul-17
Solids, %	Gravimetric, calculation	6-Jul-17	6-Jul-17

Certificate of Analysis
Client: Pinchin Ltd. (Kingston)
Client PO:

Report Date: 06-Jul-2017

Order Date: 29-Jun-2017

Project Description: 206685.000

Client ID:	P01 - Caulking, boiler room 1, exterior stack	P02 - Caulking, boiler room 2, exterior stack	-	-
Sample Date:	28-Jun-17	28-Jun-17	-	-
Sample ID:	1726478-01	1726478-02	-	-
MDL/Units	other	other	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	100	100	-	-
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PCBs

PCBs, total	0.05 ug/g dry	<5.68 [1] [2] [3]	<15.6 [1] [2] [3]	-	-
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Certificate of Analysis
Client: Pinchin Ltd. (Kingston)
Client PO:

Report Date: 06-Jul-2017

Order Date: 29-Jun-2017

Project Description: 206685.000

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
PCBs									
PCBs, total	ND	0.05	ug/g						
Surrogate: Decachlorobiphenyl	0.200		ug/g		100	60-140			

Certificate of Analysis
Client: Pinchin Ltd. (Kingston)
Client PO:

Report Date: 06-Jul-2017

Order Date: 29-Jun-2017

Project Description: 206685.000

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
PCBs									
PCBs, total	ND	0.05	ug/g wet	ND				40	
Surrogate: Decachlorobiphenyl	0.215		ug/g wet		107	60-140			
Physical Characteristics									
% Solids	85.4	0.1	% by Wt.	85.4			0.0	25	

Certificate of Analysis
Client: Pinchin Ltd. (Kingston)
Client PO:

Report Date: 06-Jul-2017

Order Date: 29-Jun-2017

Project Description: 206685.000

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
PCBs									
PCBs, total	0.378	0.05	ug/g	ND	94.5	60-140			
Surrogate: Decachlorobiphenyl	0.220		ug/g		110	60-140			

Certificate of Analysis
Client: Pinchin Ltd. (Kingston)
Client PO:

Report Date: 06-Jul-2017

Order Date: 29-Jun-2017

Project Description: 206685.000

Qualifier Notes:

Sample Qualifiers :

- 1 : Elevated Reporting Limits due to limited sample volume.
- 2 : Elevated Reporting Limit due to matrix interference.
- 3 : The surrogate recovery for this sample is not available due to sample dilution required from high analyte concentration and/or matrix interference's.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.



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Chain of Custody
(Lab Use Only)

Page 1 of 1

Client Name: Pinchin Kingston	Project Reference: 206685.000	Turnaround Time: <input type="checkbox"/> 1 Day <input type="checkbox"/> 3 Day <input type="checkbox"/> 2 Day <input checked="" type="checkbox"/> Regular Date Required: _____
Contact Name: Michel Bernier	Quote #	
Address: 2-1456 Centennial Drive, Kingston ON K7P 0K4	PO #	
Telephone: 613 541 1013	Email Address: mbernier@pinchin.com ghendry@pinchin.com	

Criteria: ☐ O. Reg. 153/04 (As Amended) Table ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☐ SUB (Storm) ☐ SUB (Sanitary) Municipality: _____ ☐ Other: _____

Matrix Type: S (Soil Sed.) GW (Ground Water) SW (Surface Water) SS (Storm Sanitary Sewer) P (Paint) A (Air) O (Other)						Required Analyses															
Parcel Order Number: 1726478-01115		Matrix	Air Volume	# of Containers	Sample Taken		PHC's F1-F4+BTEN	VOC's	PAH's	Metals by ICP	Flg	C+VI	B (HVS)	lead analysis	PCBs analysis						
Sample ID/Location Name																					
1	L001 - Beige paint on partition wall, boiler room 1	O		1	Jun-28-17	1000 hours	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	L002 - Off-white paint on perimeter wall, boiler room 2	O		1	Jun-28-17	1100 hours	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	P01 - Caulking, boiler room 1, exterior stack	O		1	Jun-28-17	1030 hours	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	P02 - Caulking, boiler room 2, exterior stack	O		1	Jun-28-17	1130 hours	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5							<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6							<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7							<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8							<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9							<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10							<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments: Please analyze paint matrix on caulking sample P02. Once analyzed, we will amend report to include sample ID as L003. Thanks

Method of Delivery: Pick-up.

Relinquished By (Sign): <i>MB</i>	Received by Driver/Depot: <i>[Signature]</i>	Received at Lab: <i>[Signature]</i>	Verified By: <i>[Signature]</i>
Relinquished By (Print): Michel Bernier	Date/Time: 29 Jun 17 2:16	Date/Time: 16 Jul 17 9:52	Date/Time: June 30 17
Date/Time: JUN-28-17, 1010 hours	Temperature: _____ °C	Temperature: _____ °C	pH Verified [] By: 11/21 11:51

APPENDIX III
Methodology

1.0 GENERAL

Pinchin conducts a room-by-room survey (rooms, corridors, service areas, exterior, etc.) to identify the hazardous building materials as defined by the scope of work. All work is conducted in accordance with our own internal Standard Operating Procedures.

Information regarding the location and condition of hazardous building materials encountered and visually estimated quantities are recorded. The locations of any samples collected are recorded on small-scale plans.

As-built drawings and previous reports are referenced where provided.

1.1 Scope Limitations

The assessment excludes the following:

- Articles belonging to the owner, tenant or occupant (e.g. stored items, furniture, appliances, etc.);
- Underground materials or equipment (e.g. vessels, drums, underground storage tanks, pipes, etc.);
- Building envelope, structural components, inaccessible or concealed materials or other items where sampling may cause consequential damage to the property;
- Energized systems (e.g. internal boiler components, elevators, mechanical or electrical components);
- Controlled products (e.g. stored chemicals, operational or process-related substances); and
- Materials not typically associated with construction (e.g. settled dust, spills, residual contamination from prior spills, etc.).

The assessment includes limited demolition of wall and ceiling finishes (drywall or plaster) to view concealed conditions at representative areas as permitted by the current building use. Limited destructive testing of flooring is conducted where possible (under carpets or multiple layers of flooring). Demolition of masonry walls (chases, shafts etc.) and exterior building finishes is conducted, where possible.

1.2 Asbestos

Pinchin conducts an inspection for the presence of friable and non-friable asbestos-containing materials (ACM). A friable material is a material that when dry can be crumbled, pulverized or powdered by hand pressure.

A separate set of samples is collected of each type of homogenous material suspected to contain asbestos. A homogenous material is defined by the US EPA as material that is uniform in texture and appearance, was installed at one time, and is unlikely to consist of more than one type or formulation of material. The homogeneous materials are determined by visual examination and available information on the phases of construction and prior renovations.

Pinchin collects samples at a rate that is in compliance with Table 1 of O.Reg. 278/05.

The sampling strategy is also based on known ban dates and phase out dates of the use of asbestos; sampling of certain building materials is not conducted after specific construction dates. In addition, to be conservative, several years past these dates are added to account for some uncertainty in the exact start/finish date of construction and associated usage of ACM.

In some cases, manufactured products such as asbestos cement pipe are visually identified without sample confirmation.

Pinchin conducts limited demolition of masonry block walls (core holes) to investigate for loose fill insulation. The core holes are temporarily patched with caulking.

If present, the following materials are presumed to be asbestos-containing and are best sampled immediately prior to commencing renovation/disturbance:

- Roofing, felts and tar; and
- Soffit and fascia boards at elevated heights.

Pinchin submits the bulk samples to a NVLAP accredited laboratory for analysis. The analysis is performed in accordance with Test Method EPA/600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials, July 1993.

In Ontario an ACM is defined as materials containing 0.5% or more asbestos by weight.

The asbestos analysis is completed using a stop positive approach. Only one result meeting the above regulated criteria is required to determine that a material is asbestos-containing, but all samples must be analyzed to conclusively determine that a material is non-asbestos. The laboratory stops analyzing samples from a homogeneous material once a result equal to or greater than the regulated criteria is detected in any of the samples of that material. All samples of a homogeneous material are analyzed if no asbestos is detected. In some cases, all samples are analyzed in the sample set regardless of result. Where building materials are described in the report as non-asbestos, this means that either no asbestos was detected by the analytical method utilized in any of the multiple samples or, if detected, it is below the lower limit of an asbestos-containing material in the applicable regulation.

Asbestos materials are evaluated in order to make recommendations regarding remedial work. The priority for remedial action is based on several factors:

- Friability (friable or non-friable);
- Condition (good, fair, poor, debris);
- Accessibility (ranking from accessible to all building users to inaccessible);
- Visibility (whether the material is obscured by other building components); and
- Efficiency of the work (for example, if damaged ACM is being removed in an area, it may be most practical to remove all ACM in the area even if it is in good condition).

1.3 Lead

Pinchin collects samples of distinctive paint finishes and surface coatings present in more than a limited application, where removal of the paint is possible. Pinchin collects samples by scraping the painted finish to include base and covering applications. Drawings included show sample locations.

Analysis for lead in paints or surface coatings is performed at an accredited laboratory in accordance with MOE Test Method E3470; Lead by Inductively Coupled Plasma, Optical Emission Spectrometry.

For this report, all paints containing lead at a concentration of 0.009% (90 ppm) or greater are discussed. Paint and surface coatings are evaluated for condition such as flaking, chipping or chalking.

Other lead building products (e.g. batteries, lead sheeting, flashing) are identified by visual observation only.

1.4 Silica

Pinchin identifies building materials suspected of containing crystalline silica (e.g. concrete, cement, tile, brick, masonry, mortar) by knowledge of current and historic applications and visual inspection only.

Pinchin does not perform sampling of these materials for laboratory analysis of crystalline silica content.

1.5 Mercury

Building materials/products/equipment (e.g. thermostats, barometers, pressure gauges, light tubes), suspected to contain mercury are identified by visual inspection only. Dismantling of equipment suspected of containing mercury is not performed. Sampling of these materials for laboratory analysis of mercury content is not performed.

1.6 Polychlorinated Biphenyls

Pinchin determines the potential for light ballasts to contain PCBs based on the age of the building, a review of maintenance records and examination of labels or nameplates on equipment, where present

and accessible. The information is compared to known ban dates of PCBs and Environment Canada publications. Other than light ballasts and pole mounted transformers, all other liquid uses of PCBs should have been discontinued.

Pinchin samples exterior caulking or sealants for PCBs based on the date of construction or installation. Caulking installed after 1985 is presumed to be free of PCBs and hence not sampled. If sampled, analysis for PCBs is performed using an ASTM test method appropriate to the sample matrix at an accredited laboratory.

1.7 Visible Mould

Pinchin identifies the presence of mould if visibly present in a significant quantity on exposed building surfaces. If any mould growth is concealed within wall cavities it is not addressed in this assessment.

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