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Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract comprises the replacement of the heating piping at the CSC Okimaw Ohci Healing Lodge, located south of Maple Creek, SK; and further identified interchangeably as "OOHL".

1.2 CONTRACT METHOD

- .1 Construct Work under stipulated price contract.

1.3 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit Project construction progress schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements
- .4 Submit site-specific and Work Plan Health and Safety Plan in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 CONTRACTOR USE OF PREMISES

- .1 Co-ordinate use of premises under direction of Owner.
- .2 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .3 Refer to Section 01 52 00 - Construction Facilities and Section 01 56 00 - Temporary Barriers and Enclosures, for temporary facilities, access roads and parking areas, traffic regulations, and utilities.
- .4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.
- .6 Ensure that operations conditions of exiting work at completion are still the same, equal to or better than that which existed before new work started.

1.5 OWNER OCCUPANCY

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.6 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.7 EXISTING SERVICES

- .1 Notify Owner, Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Owner 48 hours notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to tenant operations, pedestrian and vehicular traffic.
- .3 Provide alternative routes for personnel, pedestrian and vehicular traffic as required.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Consultant and Departmental Representative of findings.
- .5 Submit schedule for approval by Owner and Departmental Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services when directed by Departmental Representative to maintain critical building and tenant services.
- .7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .8 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .10 Record locations of maintained, re-routed and abandoned service lines.
- .11 Construct barriers, as required, in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.8 DOCUMENTS REQUIRED

- .1 Maintain at job site, one copy of each document as follows:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Reviewed Shop Drawings.
 - .5 List of Outstanding Shop Drawings.
 - .6 Change Orders.
 - .7 Other Modifications to Contract.
 - .8 Field Test Reports.

- .9 Copy of Approved Work Schedule.
- .10 Health and Safety Plan and Other Safety Related Documents.
- .11 Other documents as specified.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 ACCESS AND EGRESS

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

1.2 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Departmental Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.
- .5 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.4 EXISTING SERVICES

- .1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for pedestrian, personnel and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.5 SPECIAL REQUIREMENTS

- .1 Submit schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart
- .2 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .3 Keep within limits of work and avenues of ingress and egress.
- .4 Confirm limits to Ingress and egress of Contractor vehicles with Departmental Representative.

1.6 SECURITY

- .1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.
- .2 Security clearances:
 - .1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises.
 - .2 Obtain requisite clearance, as instructed, for each individual required to enter premises.
 - .3 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.
- .3 Security escort:
 - .1 Personnel employed on this project must be escorted when executing work in non-public areas during normal working hours. Personnel must be escorted in all areas after normal working hours.
 - .2 Submit an escort request to Departmental Representative at least 14 days before service is needed. For requests submitted within time noted above, costs of security escort will be paid for by Departmental Representative. Cost incurred by late request will be Contractor's responsibility.
 - .3 Any escort request may be cancelled free of charge if notification of cancellation is given at least 24 hours before scheduled time of escort. Cost incurred by late request will be Contractor's responsibility.
 - .4 Calculation of costs will be based on average hourly rate of security officer for minimum of 8 hours per day for late service request and of 4 hours for late cancellations.

1.7 BUILDING SMOKING ENVIRONMENT

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Owner/Contractor Agreement.

1.2 APPLICATIONS FOR PROGRESS PAYMENT

- .1 Make applications for payment on account as monthly as Work progresses.
- .2 Date applications for payment last day of agreed monthly payment period and ensure amount claimed is for value, proportionate to amount of Contract, of Work performed and Products delivered to Place of Work at that date.
- .3 Submit to Departmental Representative, at least 14 days before first application for payment. Schedule of values for parts of Work, aggregating total amount of Contract Price, to facilitate evaluation of applications for payment.

1.3 PROGRESS PAYMENT

- .1 Departmental Representative will issue to Owner, no later than 10 days after receipt of an application for payment, certificate for payment in amount applied for or in such other amount as Departmental Representative determines to be due. If Departmental Representative amends application, Departmental Representative will give notification in writing giving reasons for amendment.

1.4 SUBSTANTIAL PERFORMANCE OF WORK

- .1 Prepare and submit to Departmental Representative comprehensive list of items to be completed or corrected and apply for a review by Departmental Representative to establish Substantial Performance of Work or substantial performance of designated portion of Work when Work is substantially performed if permitted by lien legislation applicable to Place of Work designated portion which Owner agrees to accept separately is substantially performed. Failure to include items on list does not alter responsibility to complete Contract.
- .2 No later than 10 days after receipt of list and application, Departmental Representative will review Work to verify validity of application, and no later than 7 days after completing review, will notify Contractor if Work or designated portion of Work is substantially performed.
- .3 Departmental Representative: state date of Substantial Performance of Work or designated portion of Work in certificate.
- .4 Immediately following issuance of certificate of Substantial Performance of Work, in consultation with Departmental Representative, establish reasonable date for finishing Work.

1.5 PAYMENT OF HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF WORK

- .1 After issuance of certificate of Substantial Performance of Work:
 - .1 Submit application for payment of holdback amount.

- .2 Submit sworn statement that accounts for labour, subcontracts, products, construction machinery and equipment, and other indebtedness which may have been incurred in Substantial Performance of Work and for which Owner might in be held responsible have been paid in full, except for amounts properly retained as holdback or as identified amount in dispute.
- .2 After receipt of application for payment and sworn statement, Departmental Representative will issue certificate for payment of holdback amount.
- .3 Where holdback amount has not been placed in a separate holdback account, Owner will, 10 days prior to expiry of holdback period stipulated in lien legislation applicable to Place of Work, place holdback amount in bank account in joint names of Owner and Contractor.
- .4 Amount authorized by certificate for payment of holdback amount is due and payable on day following expiration of holdback period stipulated in lien legislation applicable to Place of Work. Where lien legislation does not exist or apply, holdback amount is due and payable in accordance with other legislation, industry practice, or provisions which may be agreed to between parties. Owner may retain out of holdback amount sums required by law to satisfy liens against Work or, if permitted by lien legislation applicable to Place of Work, other third party monetary claims against Contractor which are enforceable against Owner.

1.6 PROGRESSIVE RELEASE OF HOLDBACK

- .1 Where legislation permits, if Departmental Representative has certified that Work of subcontractor or supplier has been performed prior to Substantial Performance of Work, Owner will pay holdback amount retained for such subcontract Work, or products supplied by such supplier, on day following expiration of holdback period for such Work stipulated in lien legislation applicable to Place of Work.
- .2 In addition to provisions of preceding paragraph, and certificate wording, ensure that such subcontract Work or products is protected pending issuance of final certificate for payment and be responsible for correction of defects or Work not performed regardless of whether or not such was apparent when such certificates were issued.

1.7 FINAL PAYMENT

- .1 Submit application for final payment when Work is completed.
- .2 Departmental Representative will, no later than 10 days after receipt of application for final payment, review Work to verify validity of application. Departmental Representative will give notification that application is valid or give reasons why it is not valid, no later than 7 days after reviewing Work.
- .3 Departmental Representative will issue final certificate for payment when application for final payment is found valid.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

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Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting four days in advance of meeting date to Consultant and Departmental Representative.
- .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 and all affected parties not in attendance.
- .8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 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 representatives of Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3 Establish time and location of meeting and notify parties concerned minimum 12 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: in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
 - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
 - .5 Delivery schedule of specified equipment.
 - .6 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
 - .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

- .8 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .9 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .10 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Monthly progress claims, administrative procedures, photographs, hold backs.
- .12 Appointment of inspection and testing agencies or firms.
- .13 Insurances, transcript of policies.

1.3 PROGRESS MEETINGS

- .1 During course of Work, schedule progress meetings bi-weekly.
- .2 Contractor, major Subcontractors involved in Work, Owner, Consultant and Departmental Representative are to be in attendance.
- .3 Notify parties minimum 7 days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 7 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.

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END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
- .2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.
- .3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.
- .4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.
- .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
- .6 Master Plan: summary-level schedule that identifies major activities and key milestones.
- .7 Milestone: significant event in project, usually completion of major deliverable.
- .8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.
- .9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.2 REQUIREMENTS

- .1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.
- .2 Plan to complete Work in accordance with prescribed milestones and time frame.
- .3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.
- .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

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- .2 Submit to Departmental Representative & Consultant within 10 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.
- .3 Submit Project Schedule to Consultant & Departmental Representative within 5 working days of receipt of acceptance of Master Plan.

1.4 PROJECT MILESTONES

- .1 Project milestones form interim targets for Project Schedule.
 - .1 Interior finishing and fitting, mechanical, and electrical work completed within 16 weeks of Award of Contract date.
 - .2 Interim Certificate (Substantial Completion) within 20 weeks of Award of Contract date.

1.5 MASTER PLAN

- .1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).
- .2 Departmental Representative will review and return revised schedules within 5 working days.
- .3 Revise impractical schedule and resubmit within 5 working days.
- .4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.6 PROJECT SCHEDULE

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:
 - .1 Award.
 - .2 Shop Drawings, Samples.
 - .3 Permits.
 - .4 Mobilization.
 - .5 Excavation.
 - .6 Backfill.
 - .7 Electrical.
 - .8 Testing and Commissioning.
 - .9 Supplied equipment long delivery items.
 - .10 Engineer supplied equipment required dates.

1.7 PROJECT SCHEDULE REPORTING

- .1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress.
- .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

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1.8 PROJECT MEETINGS

- .1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.
- .2 Weather related delays with their remedial measures will be discussed and negotiated.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

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

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in Saskatchewan, Canada as required by Departmental Representative.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .4 Allow 10 days for Departmental Representative's review of each submission.
- .5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

- .6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .7 Accompany submissions with transmittal letter containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .8 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.
- .9 After Departmental Representative review, distribute copies.
- .10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative.

- .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
- .2 Testing must have been within 3 years of date of contract award for project.
- .13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .21 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.
 - .1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
 - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's office.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

- .1 Erect mock-ups in accordance with 01 45 00 - Quality Control.

1.5 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic copy of colour digital photography in .jpg format, standard resolution monthly with progress statement, or as directed by Departmental Representative.
- .2 Project identification: name and number of project and date of exposure indicated.

1.6 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.

END OF SECTION

Part 1 General

1.1 PRECEDENCE

- .1 For Federal Government projects, Division 1 Sections take precedence over technical specifications in other Divisions of the Project Manual.

1.2 HAZARDOUS MATERIALS

- .1 Follow methods and procedures specified in Section 02 81 00 - Hazardous Materials ; Section 02 56 13 - Waste Containment.
- .2 Provide written reports for chemical spills.
- .3 Provide copies of associated WHMIS Safety Data Sheets (SDS).
- .4 Provide location and layout of storage areas include:
 - .1 Location of water source.
 - .2 Location, type and size of venting equipment. Demonstrate controls and operation to Departmental Representative.
 - .3 Location and contents of spill kits including eye wash stations. Demonstrate contents, operation and use to Departmental Representative.
 - .4 Demonstration and measurements of negative pressure of storage areas.

1.3 EROSION AND SEDIMENTATION CONTROL

- .1 Provide copy of erosion control plan, including drawings with erosion and sedimentation control measures highlighted.

1.4 REDUCING SITE DISTURBANCES

- .1 Provide report indicating measures taken to reduce disturbances to existing topography, vegetation, geology, soils, and drainage.
- .2 Provide site plan indicating location of native species plantings and lawn areas.

1.5 GENERAL CONSTRUCTION MATERIALS/PRACTICES

- .1 Materials and Resources
 - .1 Provide written report indicating:
 - .1 Total amount of granular road base material that was used on site and what percentage of this material was post-consumer demolition material.
 - .2 Which components of project design were reused building materials.
- .2 Storage and Collection of Recyclables
 - .1 Provide floor and site plans indicating:
 - .1 Location of collection sites for recyclable materials and storage facilities in loading dock area.
 - .2 Location of composting facilities.
- .3 Construction Waste Management

- .1 Submit copy of the waste audit and waste management workplan developed for project.
- .2 Submit waybills for waste materials removed from site during construction along with destination point.
- .4 Resource Reuse
 - .1 Provide written report including specifications:
 - .1 Describing salvaged and refurbished materials used during construction, including origin of salvaged materials.
 - .2 Showing calculations that indicate what percentage of total project's materials were salvaged or refurbished.
- .5 Recycled Content
 - .1 Provide product specification and data sheets for products containing recycled content indicating the percentage of, post consumer and post industrial content.
 - .2 Provide calculations indicating what percentage of total project's materials contained recycled content.
- .6 Local/Regional Materials
 - .1 Provide product specification and data sheets for locally manufactured materials installed.
 - .2 Provide calculations indicating what percentage of total project's materials were locally manufactured.
- .7 Rapidly Renewable Materials
 - .1 Provide product specification and data sheets for products containing rapidly renewable materials installed.
 - .2 Provide calculations indicating what percentage of total project's materials contained rapidly renewable materials.
- .8 Wood
 - .1 Provide documentation from supplier declaring that wood materials were harvested from sustainable forestry practices.
 - .2 Provide calculations indicating what percentage of total project's wood materials were certified as sustainably harvested.
- .9 Low-Emitting Materials
 - .1 Provide WHMIS Safety Data Sheets (SDS) or testing results indicating VOC emission rates for following materials:
 - .1 Adhesives.
 - .2 Sealants.
 - .3 Caulkings.
 - .4 Paints and coatings.
 - .5 Textile floor coverings.
 - .2 Provide WHMIS Safety Data Sheets (SDS) sheets indicating resin type for composite wood and agrifibre materials.

1.6 INSULATION

- .1 Provide product specification and data sheets indicating:
 - .1 Recycled content of each type of insulation material installed.

1.7 PAINTS, STAINS, VARNISHES

- .1 Provide WHMIS Safety Data Sheets (SDS) for paints, stains and varnishes indicating VOC emission rate and chemical composition.

1.8 SEALANTS, ADHESIVES AND COMPOUNDS

- .1 Provide WHMIS Safety Data Sheets (SDS) for sealants, adhesives and other compounds indicating VOC emission rate and chemical composition.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Province of Saskatchewan
 - .1 Occupational Health and Safety Act, R.S.A. – Latest Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit 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 3 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative.
- .4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit WHMIS Safety Data Sheets (SDS) in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .7 Departmental Representative 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 within 5 days after receipt of comments from Departmental Representative.
- .8 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.
- .10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.3 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.
- .2 Contractor shall agree to install proper site separation and identification in order to maintain time and space at all times throughout life of project.

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1.4 SAFETY ASSESSMENT

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

1.5 MEETINGS

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

1.6 REGULATORY REQUIREMENTS

- .1 Do Work in accordance with Section 01 41 00 - Regulatory Requirements.

1.7 GENERAL REQUIREMENTS

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.8 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, and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.9 COMPLIANCE REQUIREMENTS

- .1 Comply with Occupational Health and Safety Act, General Safety Regulation, Saskatchewan Reg. (2018 Edition).

1.10 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 verbally and in writing.

1.11 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.

1.12 CORRECTION OF NON-COMPLIANCE

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

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- .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.13 BLASTING

- .1 Blasting or other use of explosives is not permitted.

1.14 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

1.15 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.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section references to laws, by laws, ordinances, rules, regulations, codes, orders of Authority Having Jurisdiction, and other legally enforceable requirements applicable to Work and that are; or become, in force during performance of Work.

1.2 REFERENCES TO REGULATORY REQUIREMENTS

- .1 Department of Justice Canada (Jus)
 - .1 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
 - .2 Perform Work in accordance with 2019 National Building Code of Canada including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
 - .3 Specific design and performance requirements listed in specifications or indicated on Drawings may exceed minimum requirements established by referenced Building Code; these requirements will govern over the minimum requirements listed in Building Code
 - .1 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

1.3 HAZARDOUS MATERIAL DISCOVERY

- .1 Asbestos: demolition of spray or trowel-applied asbestos is hazardous to health. Stop work immediately when material resembling spray or trowel-applied asbestos is encountered during demolition work. Notify Departmental Representative.
- .2 PCB: Polychlorinated Biphenyl: stop work immediately when material resembling Polychlorinated Biphenyl is encountered during demolition work. Notify Departmental Representative.
- .3 Mould: stop work immediately when material resembling mould is encountered during demolition work. Notify Departmental Representative.

1.4 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions and municipal by-laws.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: Except as otherwise specified, Contractor shall apply for, obtain, and pay fees associated with, permits, licenses, certificates, and approvals required by regulatory requirements and Contract Documents, based on General Conditions of Contract and the following:
 - .1 Regulatory requirements and fees in force on date of Bid submission, and

- .2 A change in regulatory requirements or fees scheduled to become effective after date of tender submission and of which public notice has been given before date of tender submission

Part 2 Products

2.1 PERMITS

- .1 Building Permit:
 - .1 Contractor shall apply for, obtain and pay for building permit on behalf of Owner, and other permits required for Work and its various parts.
- .2 Occupancy Permits:
 - .1 Contractor shall apply for, obtain, and pay for occupancy permits, including partial occupancy permits where required by authority having jurisdiction.
 - .2 Departmental Representative will issue appropriate instructions to Contractor for correction to Work where Contract Document deficiencies are required to be corrected in order to obtain occupancy permits, including partial occupancy permits.
 - .3 Contractor shall correct deficiencies in accordance with Departmental Representative's instructions. Where deficiency is not corrected, Owner reserves the right to make correction and charge Contractor for costs incurred.
 - .4 Contractor shall turn occupancy permits over to Owner.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 INSPECTION

- .1 Allow Departmental Representative and 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.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative or Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative 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.

1.2 PROCEDURES

- .1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in 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.

1.3 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative or Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Departmental Representative or Departmental Representative 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 Consultant.

1.4 REPORTS

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

- .2 Provide copies to subcontractor of work being inspected or tested, or manufacturer or fabricator of material being inspected or tested if requested.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 PRECEDENCE

- .1 For Federal Government Projects, Division 01 Sections take precedence over technical specifications in other Divisions of this Project Manual.

1.2 REFERENCE STANDARDS

- .1 Underwriters Laboratories (UL)
 - .1 UL 2761-[11], Sealants and Caulking Compounds
 - .2 UL 2762-[11], Adhesives
 - .3 UL 2768-[11], Architectural Surface Coatings

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submittals required:
 - .1 Compliance Report indicating requirement to purchase energy efficient and environmentally benign products.
 - .2 Use Report indicating understanding of requirement to use materials and methods of construction, which improve energy and water efficiency, reduce hazardous by-products, and use recycled materials, or materials, which can be reused.
 - .3 Building systems and material evaluation report.
- .3 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 43 - Environmental Procedures & 01 35 29.06 - Health and Safety Requirements. Indicate VOC emissions, prior to installation or use:
 - .1 Adhesives.
 - .2 Caulking compounds.
 - .3 Sealants.
 - .4 Insulating materials.
 - .5 Fireproofing or fire stopping materials.
 - .6 Paints.
 - .7 Floor and wall patching or levelling materials.
 - .8 Lubricants.
- .4 Construction Schedule:
 - .1 Submit schedule of construction prior to start of work, in co-ordination with scheduling requirements, including:
 - .1 Sequence of finish applications and allowances for curing times.
 - .2 Identification of finish types. See Table A
 - .3 Schedule and duration of proposed temporary ventilation.

- .4 Delivery schedules of manufactured materials which are anticipated to off-gas in timely manner, which will allow for airing of those materials prior to their scheduled installation.
 - .5 Indicate and schedule commissioning procedures and temporary usages of building mechanical systems, identifying types of filtration and schedule for filter replacement.
- .5 IAQ Management Plan:
- .1 Submit Indoor Air Quality (IAQ) Management Plan for construction and preoccupancy phases of building.

1.4 HAZARDOUS MATERIALS

- .1 Follow methods and procedures specified in Section 02 81 00 - Hazardous Materials ; Section 02 56 13 - Waste Containment.
- .2 Take measures to ensure chemical spills do not enter drains.
- .3 Provide proper storage and containment of herbicides and indoor pesticides.
 - .1 Design and construction of storage spaces for hazardous materials in accordance with authorities having jurisdiction.
 - .2 Include ventilation of areas, which contain potential sources of air contamination.
 - .1 Comply with standards for storage of flammable, combustible and hazardous materials, explosives, compressed gas cylinders, and reactive, corrosive and oxidizing materials.
 - .3 Storage conditions, ventilation requirements, construction materials storage areas, containers, drums and tanks, compatibility issues, and labelling: in accordance with federal and municipal guidelines supplemented as follows:
 - .1 Confine storage of chemicals and hazardous wastes to designated areas with security of access.
 - .2 Ensure access to hose bib and water for mixing concentrated chemicals.
 - .3 Include containment to prevent spills from entering drains.
 - .4 Include venting to exterior.
 - .5 Keep storage areas under negative pressure, where possible.

1.5 PAINTS, STAINS, AND VARNISHES

- .1 Use paints and coatings with VOC limits to UL 2768, GC-03, SCAQMD Rule 1113, CCD-048, and GS-11.

1.6 ADHESIVES, SEALANTS, AND CAULKING COMPOUNDS

- .1 Use adhesives with VOC limits to UL 2762, and SCAQMD Rule 1168.
- .2 Use sealant and caulking products with VOC limits to SCAQMD Rule 1168 and UL 2761.

1.7 EXTERIOR SITE

- .1 Take measures to prevent soil erosion before, during, and after construction by controlling storm-water runoff and wind erosion.

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Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Canadian General Standards Board (CGSB)
 - .1 CGSB 1.59-[97], Alkyd Exterior Gloss Enamel.
 - .2 CAN/CGSB 1.189-[00], Exterior Alkyd Primer for Wood.
- .2 CSA Group (CSA)
 - .1 CSA-O121-[M1978 (R2003)], Douglas Fir Plywood.
- .3 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as Of: May 14, 2004.

1.2 INSTALLATION AND REMOVAL

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from site all such work after use.

1.3 GUARD RAILS AND BARRICADES

- .1 Provide secure, rigid guard rails and barricades around excavations.

1.4 ACCESS TO SITE

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

1.5 PUBLIC TRAFFIC FLOW

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

1.6 FIRE ROUTES

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

1.7 PROTECTION OF BUILDING FINISHES

- .1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.
- .2 Provide necessary screens, covers, and hoardings.
- .3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.
- .4 Be responsible for damage incurred due to lack of or improper protection.

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1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Within text of each specifications section, reference may be made to reference standards.
- .2 Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .3 If there is question as to whether products or systems are in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.
- .4 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.

1.2 QUALITY

- .1 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.
- .2 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.
- .3 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.
- .4 Should disputes arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.
- .5 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.3 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, and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.4 TRANSPORTATION

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

1.5 MANUFACTURER'S INSTRUCTIONS

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .2 Notify Departmental Representative in writing, of conflicts between specifications and manufacturer's instructions, so that Departmental Representative will establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in Contract Price or Contract Time.

1.6 QUALITY OF WORK

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Departmental Representative if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.
- .3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

1.7 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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1.8 CONCEALMENT

- .1 In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform Departmental Representative if there is interference. Install as directed by Departmental Representative.

1.9 REMEDIAL WORK

- .1 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.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.10 LOCATION OF FIXTURES

- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform Departmental Representative of conflicting installation. Install as directed.

1.11 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.12 FASTENINGS - EQUIPMENT

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

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1.13 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 Departmental Representative.

1.14 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, 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.

END OF SECTION

Part 1 General

1.1 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.

1.2 MATERIALS

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

1.3 PREPARATION

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

1.4 EXECUTION

- .1 Execute cutting, fitting, and patching, including excavation and fill, to complete Work.
- .2 Fit several parts together, to integrate with other Work.

- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .9 Restore work with new products in accordance with requirements of Contract Documents.
- .10 Fit Work to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .11 Provide firestopping in accordance with Section 07 84 00 - Firestopping to maintain the integrity of fire separations, including:
 - .1 Protecting penetrations at fire-resistance rated wall, ceiling or floor construction.
 - .2 Using construction joint fire stops and building perimeter fire stops to protect gaps at fire separations and between fire separations and other construction assemblies.
- .12 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .13 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 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.
- .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 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .7 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .8 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .9 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .10 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris including that caused by Owner or other Contractors.
- .5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.

- .9 Clean lighting reflectors, lenses, and other lighting surfaces.
- .10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .11 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .12 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .13 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .14 Remove dirt and other disfiguration from exterior surfaces.
- .15 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .16 Sweep and wash clean paved areas.
- .17 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .18 Clean roofs, downspouts, and drainage systems.
- .19 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .20 Remove snow and ice from access to building.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Acceptance of Work Procedures:
 - .1 Contractor's Inspection: Contractor conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
 - .2 Request Departmental Representative's inspection.
 - .2 Departmental Representative's Inspection:
 - .1 Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.
 - .2 Contractor to correct Work as directed.
 - .3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:
 - .1 Work: completed and inspected for compliance with Contract Documents.
 - .2 Defects: corrected and deficiencies completed.
 - .3 Equipment and systems: tested, adjusted and fully operational.
 - .4 Certificates required by Fire Commissioner: submitted.
 - .5 Operation of systems: demonstrated to Owner's personnel.
 - .6 Work: complete and ready for final inspection.
 - .4 Final Inspection:
 - .1 When completion tasks are done, request final inspection of Work by Departmental Representative and Contractor.
 - .2 When Work incomplete according to Departmental Representative, complete outstanding items and request re-inspection.
 - .5 Declaration of Substantial Performance: when Departmental Representative considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.
 - .6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.
 - .7 Final Payment:
 - .1 When Departmental Representative considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

- .8 Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

1.2 FINAL CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-warranty Meeting:
 - .1 Convene meeting one week prior to contract completion with Departmental Representative, in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify Project requirements.
 - .2 Review warranty requirements.
 - .2 Departmental Representative to establish communication procedures for:
 - .1 Notifying construction warranty defects.
 - .2 Determine priorities for type of defects.
 - .3 Determine reasonable response time.
 - .3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.
 - .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 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 Departmental Representative final copies 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.

1.3 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, 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.

1.4 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 Departmental Representative 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].
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

1.5 AS -BUILT DOCUMENTS AND SAMPLES

- .1 Maintain, at site Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field Test Report, System Components List C/W Commissioning Verification Forms and Check Sheets and Commissioning Issues/Resolution Log. Inspection certificates.
 - .7 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.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

- .1 Record information on set of black line opaque drawings provided by Departmental Representative.
- .2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress.
 - .1 Do not conceal Work until required information is recorded.
- .4 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 Referenced Standards to related shop drawings and modifications.
- .5 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.
- .6 Other Documents: maintain field test records, inspection certifications, and manufacturer's certifications required by individual specifications sections.
- .7 Provide digital photos, if requested, for site records.

1.7 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 Include installed colour coded wiring diagrams.
- .3 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.

- .4 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .5 Provide servicing and lubrication schedule, and list of lubricants required.
- .6 Include manufacturer's printed operation and maintenance instructions.
- .7 Include sequence of operation by controls manufacturer.
- .8 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .9 Provide installed control diagrams by controls manufacturer.
- .10 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .11 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .12 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .13 Include test and balancing reports as specified in Section 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS
- .14 Additional requirements: as specified in individual specification sections.

1.8 MATERIALS AND FINISHES

- .1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
 - .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.

1.9 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 site; 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 site; 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 site ; place and store.
 - .4 Receive and catalogue items.
 - .1 Submit inventory listing to Departmental Representative.
 - .2 Include approved listings in Maintenance Manual.

1.10 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.

1.11 WARRANTIES AND BONDS

- .1 Develop warranty management plan to contain information relevant to Warranties.
- .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Departmental Representative approval.
- .3 Warranty management plan to include required actions and documents to assure that Departmental Representative receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .5 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.
- .6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:
 - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within [ten] days after completion of applicable item of work.
- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint 6 month and 12 month warranty inspection, measured from time of acceptance, by Departmental Representative and Consultant.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
 - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include sprinkler systems, alarm systems, fire protection.
 - .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
 - .4 Contractor's plans for attendance at 6 and 12 month post-construction warranty inspections.
 - .5 Procedure and status of tagging of equipment covered by extended warranties.
 - .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

- .10 Respond in timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification to follow oral instructions.
 - .1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

1.12 WARRANTY TAGS

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Departmental Representative.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate following information on tag:
 - .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

- .1 Demonstrate operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of final inspection
- .2 Owner: provide list of personnel to receive instructions, and co-ordinate their attendance at agreed-upon times.
- .3 Preparation:
 - .1 Verify conditions for demonstration and instructions comply with requirements.
 - .2 Verify designated personnel are present.
 - .3 Ensure equipment has been inspected and put into operation in accordance with relevant Sections.
 - .4 Ensure testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS and equipment and systems are fully operational.
- .4 Demonstration and Instructions:
 - .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the designated location.
 - .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
 - .3 Review contents of manual in detail to explain aspects of operation and maintenance.
 - .4 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Departmental Representative's approval.
- .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4 Give time and date of each demonstration, with list of persons present.
- .5 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.3 QUALITY ASSURANCE

- .1 When specified in individual Sections requiring manufacturer to provide authorized representative to demonstrate operation of equipment and systems:
 - .1 Instruct Owner's personnel.

- .2 Provide written report that demonstration and instructions have been completed.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
 - .2 Acronyms:
 - .1 AFD - Alternate Forms of Delivery, service provider.
 - .2 BMM - Building Management Manual.
 - .3 Cx - Commissioning.
 - .4 EMCS - Energy Monitoring and Control Systems.
 - .5 O&M - Operation and Maintenance.
 - .6 PI - Product Information.
 - .7 PV - Performance Verification.
 - .8 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with Contract Documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the BMM.
 - .3 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

- .1 Section 01 91 13.13 - Commissioning Plan.
- .2 For Cx responsibilities refer to Section 01 91 13.13 - Commissioning Plan.

- .3 Cx to be a line item of Contractor's cost breakdown.
- .4 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .6 Departmental Representative will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
 - .2 Equipment, components, systems, and integrated systems have been fully commissioned and functional as per design intent to meet contract specification and project functional and operational requirements.
 - .3 Completion of Training session to Operational and Maintenance staffs.
 - .4 Final O&M and Training Manual receive, review and approve by Departmental Representative for suitability.
 - .5 Successful completion of integrated system tests, and after meeting all requirements of the authority having jurisdiction.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review Contract Documents, confirm by writing to Departmental Representative:
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.

- .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Departmental Representative.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.
 - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

- .1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit no later than 4 weeks after award of Contract:
 - .1 Name of Contractor's Cx agent.
 - .2 Draft Cx documentation.
 - .3 Preliminary Cx schedule.
 - .2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least [8] weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least [8] weeks prior to start of Cx.
 - .4 Provide additional documentation relating to Cx process required by Departmental Representative or Departmental Representative.

1.8 COMMISSIONING DOCUMENTATION

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms for requirements and instructions for use.
- .2 Departmental Representative to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Departmental Representative.

1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.
 - .4 Training.

1.10 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following project meetings: Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60 % construction completion stage. Section 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by Departmental Representative, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at [60] % and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

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

1.12 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days notice prior to commencement.
- .2 Departmental Representative to witness of start-up and testing.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by Departmental Representative.
 - .3 Arrange for Departmental Representative and/or Departmental Representative to witness tests.
 - .4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results

reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

- .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
- .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit to Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

- .1 Notify Departmental Representative and Consultant at least 21 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS/EQUIPMENT

- .1 Submit to Departmental Representative for review and approval:
 - .1 Complete list of instruments proposed to be used.
 - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 2-way radios.
 - .2 Ladders.
 - .3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 Under accepted simulated operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.

1.21 WITNESSING COMMISSIONING

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

1.22 AUTHORITIES HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Departmental Representative within 5 days of test and with Cx report.

1.23 EXTRAPOLATION OF RESULTS

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

1.24 EXTENT OF VERIFICATION

- .1 General:
 - .1 Provide manpower and instrumentation to verify up to 30 % of reported results, unless specified otherwise in other sections.

- .2 Number and location to be at discretion of Departmental Representative.
- .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .4 Review and repeat commissioning of systems if inconsistencies found in more than 20 % of reported results.
- .5 Perform additional commissioning until results are acceptable to Departmental Representative.

1.25 REPEAT VERIFICATIONS

- .1 Assume costs incurred by Departmental Representative for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Departmental Representative's and/or Departmental Representative's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Departmental Representative deems Contractor's request for second verification was premature.

1.26 SUNDRY CHECKS AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

1.27 DEFICIENCIES, FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative.
- .2 Report problems, faults or defects affecting Cx to Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative.

1.28 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative and Consultant.

1.29 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.30 TRAINING

- .1 In accordance with Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

1.31 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.32 OCCUPANCY

- .1 Cooperate fully with Departmental Representative during stages of acceptance and occupancy of facility.

1.33 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited with Departmental Representative.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.34 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10 % of specified values.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

1.35 OWNER'S PERFORMANCE TESTING

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

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END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Description of overall structure of Plan and roles and responsibilities of commissioning team.

1.2 REFERENCE STANDARDS

- .1 CSA -Z320-11 - Building Commissioning Standard.Public Works and Government Services Canada (PWGSC)
- .2 ASHRAE 202-2013 – Commissioning Process for Building and System.
- .3 Underwriters' Laboratories of Canada (ULC)

1.3 GENERAL

- .1 Provide a fully functional facility :
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 Facility user and O&M personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
- .2 Term “Cx”; in this section means “Commissioning”;
- .3 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
 - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to O&M, process and administration of Cx.
 - .4 Describes process of verification of how built works meet design and Owner requirements.
 - .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
 - .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.
 - .2 General description of elements that make up Cx Plan.
 - .3 Process and methodology for successful Cx.
- .4 Acronyms:

- .1 Cx - Commissioning.
 - .2 BMM - Building Management Manual.
 - .3 EMCS - Energy Monitoring and Control Systems.
 - .4 WHMIS Safety Data Sheets (SDS).
 - .5 PI - Product Information.
 - .6 PV - Performance Verification.
 - .7 TAB - Testing, Adjusting and Balancing.
 - .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
- .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
 - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

- .1 Cx Plan to be 95% completed before added into Project Specifications.
- .2 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:
 - .1 Approved shop drawings and product data.
 - .2 Approved changes to contract.
 - .3 Contractor's project schedule.
 - .4 Cx schedule.
 - .5 Contractor's, sub-contractor's, suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .3 Submit completed Cx Plan to Departmental Representative and obtain written approval.

1.5 REFINEMENT OF CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.
- .2 Revise, refine and update every month during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:

- .1 Departmental Representative Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
- .2 Departmental Representative Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
- .3 Departmental Representative is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing, certifying accuracy of reported results.
 - .4 Witnessing and certifying TAB and other tests.
 - .5 Developing BMM.
 - .6 Ensuring implementation of final Cx Plan.
 - .7 Performing verification of performance of installed systems and equipment.
 - .8 Implementation of Training Plan.
- .4 Construction Team: contractor, subcontractors, suppliers and support disciplines, is responsible for construction/installation in accordance with Contract Documents, including:
 - .1 Testing.
 - .2 TAB.
 - .3 Performance of Cx activities.
 - .4 Delivery of training and Cx documentation.
 - .5 Assigning one person as point of contact with Departmental Representative and PWGSC Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation contractor/subcontractor:
 - .1 Equipment and systems except as noted.
 - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
 - .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
 - .4 Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
 - .5 Client: responsible for intrusion and access security systems.
 - .6 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O&M personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.
 - .2 Changes to heating or cooling loads beyond scope of EMCS.
 - .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
 - .7 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

- .1 Commission mechanical systems and associated equipment:
 - .1 HVAC and exhaust systems:
 - .1 Glycol heating system.
 - .2 Noise and vibration control systems for mechanical systems.
 - .3 IAQ environmental control systems:
 - .1 Indoor conditions
 - .4 EMCS:
 - .1 Heating system

1.9 DELIVERABLES RELATING TO O&M PERSPECTIVES

- .1 General requirements:
 - .1 Compile English documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS) identification system used.
 - .5 WHMIS information.
 - .6 WHMIS Safety Data Sheets (SDS).
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.
 - .8 Preventive maintenance program.
 - .9 Standard Operating Procedures (SOP).
 - .10 Contractor's and sub-contractors' as built drawings.

1.10 DELIVERABLES RELATING TO THE CX PROCESS

- .1 General:
 - .1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2 Definitions:
 - .1 Cx as used in this section includes:
 - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
 - .2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Tests performed by Owner/User.
 - .10 Training Plans.
 - .11 Cx Reports.

- .12 Prescribed activities during warranty period.
- .4 Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative.
- .5 Departmental Representative to participate.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: by Departmental Representative prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
 - .2 Departmental Representative to use approved check lists.
 - .3 Departmental Representative will monitor of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and “bumping”; during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and does not form part of Cx specifications.
 - .6 Departmental Representative will monitor some of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - MECHANICAL:
 - .1 HVAC equipment and systems:
 - .1 “Bump” each item of equipment in its “stand-alone”; mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Departmental Representative.
 - .2 EMCS:
 - .1 EMCS trending to be available as supporting documentation for performance verification.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Carry out point-by-point verification.
 - .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
 - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
 - .6 Only additional testing after foregoing have been successfully completed to be “Off-Season Tests”.

1.12 START-UP

- .1 Start up components, equipment and systems.

- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
 - .1 HVAC System
- .3 Departmental Representative to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative .
- .4 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Departmental Representative.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Departmental Representative to witness and certify reported results using approved PI and PV forms.
 - .4 Departmental Representative to approve completed PV reports and provide to Departmental Representative.
 - .5 Departmental Representative reserves right to verify up to 30 % of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Perform Cx by specified Cx agency using procedures developed by Departmental Representative and Consultant and approved by Departmental Representative.
- .2 Departmental Representative to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.
- .4 Departmental Representative to witness, certify reported results of, Cx activities and forward to Departmental Representative.
- .5 Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

- .1 Cx to be performed by specified Cx specialist, using procedures developed by Departmental Representative and Consultant and approved by Departmental Representative.
- .2 Tests to be witnessed by Departmental Representative and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Departmental Representative and submitted to Departmental Representative for review.
- .4 Departmental Representative reserves right to verify percentage of reported results.
- .5 Integrated systems to include:
 - .1 HVAC and associated systems forming part of integrated HVAC systems:

- .2 Environmental space conditions.
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance Departmental Representative, Contractor, Departmental Representative, and Cx Manager to cooperate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.15 INSTALLATION CHECK LISTS (ICL)

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

- .1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI)/Performance Verification (PV) Forms.

1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX

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

1.19 CX SCHEDULES

- .1 Prepare detailed Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
 - .1 Design criteria, design intents.
 - .2 Pre-TAB review: [28] days after contract award, and before construction starts.
 - .3 Cx agents' credentials: [60] days before start of Cx.
 - .4 Cx procedures: [3] months after award of contract.
 - .5 Cx Report format: [3] months after contract award.
 - .6 Discussion of heating/cooling loads for Cx: [3] months before start-up.
 - .7 Submission of list of instrumentation with relevant certificates: [21] days before start of Cx.
 - .8 Notification of intention to start TAB: [21] days before start of TAB.
 - .9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
 - .10 Notification of intention to start Cx: [14] days before start of Cx.

- .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed [14] days before start of integrated system Cx.
- .12 Identification of deferred Cx.
- .13 Implementation of training plans.
- .14 Cx reports: immediately upon successful completion of Cx.
- .15 Emergency evacuation exercises: after 80 %.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to CSC.
- .3 [6] months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Departmental Representative, Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.

1.20 CX REPORTS

- .1 Submit reports of tests, witnessed and certified by Departmental Representative and Consultant to Departmental Representative who will verify reported results.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Departmental Representative.

1.21 ACTIVITIES DURING WARRANTY PERIOD

- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
 - .1 Fine tuning of HVAC systems.
 - .2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.
 - .3 Full-scale emergency evacuation exercises.

1.22 TESTS TO BE PERFORMED BY OWNER/USER

- .1 None is anticipated on this project.

1.23 TRAINING PLANS

- .1 Refer to Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

1.24 FINAL SETTINGS

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.

1.2 INSTALLATION/START-UP CHECK LISTS

- .1 Include the following data:
 - .1 Product manufacturer's installation instructions and recommended checks.
 - .2 Special procedures as specified in relevant technical sections.
 - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Departmental Representative supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Departmental Representative. Check lists will be required during Commissioning and will be included in Building Maintenance Manual (BMM) at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the BMM at completion of work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Departmental Representative's approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.
- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Departmental Representative's approval.

1.5 SAMPLES OF COMMISSIONING FORMS

- .1 Departmental Representative will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.
- .2 Revise items on Commissioning forms to suit project requirements.
- .3 Samples of Commissioning forms and a complete index of produced to date will be attached to this section.

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from Departmental Representative or Departmental Representative develop appropriate verification forms and submit to Departmental Representative for approval prior to use.
 - .1 Additional commissioning forms to be in same format as provided by Departmental Representative

1.7 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Departmental Representative provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.
 - .8 Form to bear signatures of recording technician and reviewed and signed off by Departmental Representative.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Departmental Representative with originals of completed forms.
 - .12 Maintain copy on site during start-up, testing and commissioning period.
 - .13 Forms to be both hard copy and electronic format with typed written results in Building Management Manual in accordance with Section 01 92 00 - Facility Operation.

1.8 LANGUAGE

- .1 To suit the language profile of the awarded contract.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

- .1 National Research Council Canada (NRCC)
 - .1 National Building Code (NBC)
 - .2 National Energy Code of Canada (NECB)

1.2 DEFINED TERMS

- .1 The definitions of this section are not meant to supersede definitions of the Building Code, Standards, or Contract Documents and apply only to these Contract Documents.
- .2 *As-built Drawing or Document* means a document that reflects the installed, fabricated, constructed, or commissioned condition of an item or project based on information provided by another party and not verified by the professional engineer.
- .3 *As Indicated* means the item is to be as specified or shown as per the drawings.
- .4 *Cash Allowance* means a cost for materials or work that is known to definitely be required, but which cannot be specified with adequate detail to permit accurate pricing by the Contractor at the time of the bid call. A *cash allowance* excludes any amounts for the Contractor's overhead and profit on the *cash allowance* item, which the Contractor is required to carry separately in the Contract Price.
- .5 *Contract Documents* means all documents including the engineering and architectural drawings and specifications as defined in the construction contracts for constructing the building.
- .6 *Deferred Work* means work which the Owner, Consultant, and Contractor agree, or out of necessity, simply cannot be completed in a timely manner and is therefore excluded from the calculation in determining whether *substantial performance* of a contract has been reached.
- .7 *Deficient Work* means work that has been performed, but performed incorrectly or to an inadequate standard, not performed as specified, or damaged prior to turnover to the Owner.
- .8 *Equipment Start-up* means work that is performed by the Contractor in conjunction with the equipment Manufacturer to get the systems ready for *commissioning* or *testing*.
- .9 *Furnish* means supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- .10 *Incomplete Work* means work specified in the *Contract Documents* that has not been performed or completed.
- .11 *Install* means unloading, temporary storage, unpacking, assembly, erecting, placing, anchoring, applying working to dimension, finishing curing, protecting, cleaning, and similar operations.
- .12 *Operation and Maintenance Manual* means a collection of information containing all necessary technical information on building systems for the building owner/user to carry out maintenance and operation.

- .13 *Provide* means to furnish and install, complete and ready for the intended use.
- .14 *Ready for Use for the Purpose Intended* means the system or equipment is safe, code compliant, functionally complete, and ready to be turned over to the building Owner. The specific definition of *ready for use for the purpose intended* is project specific and is the discretion of the Consultant.
- .15 *Record Drawing or Document* means a professional document prepared by a professional engineer to record design changes to an initial design for which he or she has accepted responsibility and which represents the final design of the project. Typically issued or retained as verification that on-site conditions are in accordance with the final design.
- .16 *Samples* means physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.
- .17 *Seasonal Testing* means testing of equipment and systems that have been functionally tested during winter or summer conditions and require retesting during the opposite conditions.
- .18 *Shop Drawings* means drawings, diagrams, illustrations, schedules, performance charts, brochures, product data, and other data specifically prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate details of portions of the work. *Shop Drawings* do not form part of the Contract Documents.
- .19 *Submittals* means items required by the *Contract Documents* to be submitted by the Contractor, such as requests for payment, progress reports, *Shop Drawings*, manufacturer's literature on equipment, reports, schedules. *Submittals* are normally used by the registered professional of record to aid in ascertaining whether the work substantially complies in all material respects with the plans and supporting documents prepared by the registered professional of record.
- .20 *Testing* means work that is performed by the Contractor during installation to prove the quality and workmanship before the equipment or systems are put "on-line".
- .21 *Warranty Work* means completed work that requires completion after the date of a substantial performance and is discovered prior to expiry of the contract warranty period.
- .22 *Work* means any activity, duty or function defined by the *Contract Documents*, the Alberta Building Code, work carried out on or about the construction site or on, in or about a building.

1.3 ABBREVIATIONS

- .1 AABC – Associated Air Balance Council
- .2 AHU – Air Handling Unit
- .3 ANSI – American National Standards Institute
- .4 ASTM – American Society for Testing of Materials
- .5 ASHRAE – American Society of Heating Refrigeration and Air Conditioning Engineers
- .6 ASME – American Society of Mechanical Engineers
- .7 BAS – Building Automation System

- .8 CEMA – Canadian Electrical Manufacturers Association
- .9 CGA – Canadian Gas Association
- .10 CGSB – Canadian General Standards Board
- .11 CSA – Canadian Standards Association
- .12 FM – Factory Mutual Engineering Corporation
- .13 HVAC – Heating, Ventilation, and Air Conditioning
- .14 IAO – Insurer's Advisory Organization of Canada
- .15 MERV – Minimum Efficiency Reporting Value
- .16 NECB – Model National Energy Code for Buildings
- .17 NBC – National Building Code
- .18 NC – Noise Criteria
- .19 NFPA – National Fire Protection Association
- .20 NEMA – National Electrical Manufacturers Association
- .21 OH&S – Occupational Health and Safety
- .22 PPE – Personal Protective Equipment
- .23 RC – Room Criteria (for noise measurement)
- .24 SMACNA – Sheet Metal and Air Conditioning Contractors National Association
- .25 ULC – Underwriter's Laboratory of Canada

1.4 INTENT

- .1 This Section specifies the common requirements for the work of Divisions 20 through 25 supplemented by the requirements of Division 01.
- .2 Mechanical Division Contract Documents
 - .1 The mechanical Division Contract Documents shall be read in conjunction with the manufacturer's installation instructions.
 - .2 The Mechanical Contract Documents are copyright and may not be reproduced without the explicit written permission of SNC-Lavalin.
- .3 Mechanical Drawings
 - .1 The mechanical drawings are not detailed installation instructions and do not show every pipe or duct elbow, fitting, valve, or system component required by the specifications or show the exact required routing of the services unless specifically indicated.
 - .2 The intended purpose of the mechanical drawings is to show, graphically, quantities and locations of tagged equipment, and how the products interface with other materials and products.

- .3 The mechanical drawings are diagrammatic and only approximately to scale even when scales are indicated. Do not scale from the mechanical drawings in order to determine dimensions or distances.
- .4 Mechanical Specifications
 - .1 The intent of the mechanical specifications is to define the quality and types of materials and workmanship upon which the contract is based.
 - .2 The mechanical specifications shall be read in conjunction with the mechanical drawings.
 - .3 Where codes or standards are referenced in the mechanical specifications, conform to the date or version of the code or standards referenced by the provincial building code in effect at the time of the submission of bids unless a specific date or edition is referenced.
- .5 Contract Document Discrepancies
 - .1 Review the entire set of Contract Documents (i.e. drawings and specifications of all Divisions) prior to bidding on the work.
 - .2 Where a specific requirement is identified in any portion of the Contract Documents (plan drawing, specifications, equipment schedules, details, sections, schematics, etc.) it shall be considered as a requirement of the Contract Documents regardless of whether it appears, or is represented consistently elsewhere in the Contract Documents.
 - .3 Where a discrepancy exists between portions of the Contract Documents:
 - .1 Submit a written request for clarification during the tendering phase.
 - .2 If a written request for clarification is not received by the Consultant, or if there is insufficient time for the Consultant to provide a written clarification of the design intent by means of an Addendum, include the cost for BOTH requirements inclusive of all affected trades. Do not choose to carry the cost of one interpretation over the other.
 - .3 The Consultant reserves the right to clarify the design intent once a discrepancy within the Contractor Documents has been identified at no additional cost to the Owner.
 - .4 Work that has taken place relating to the discrepancy without first requesting clarification of the design intent is subject to removal and replacement at no additional cost to the Owner.
 - .5 A credit shall be provided for work or equipment deemed to be unnecessary after the design intent is confirmed by the Consultant.
- .6 Delegated Design Responsibilities to the Contractor
 - .1 Where design responsibilities are specifically delegated to the Contractor in the Contract Documents:
 - .1 The services shall be provided by a proper licensed professional.
 - .2 Documents shall bear such professional's written approval when submitted to the Consultant.

- .3 The Owner and Consultant shall be entitled to rely on the adequacy, accuracy, and completeness of the services, certifications, or approvals performed or provided by such design professionals.
- .4 The licensed designer's signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by the Designer.

1.5 SUSTAINABILITY REQUIREMENTS

- .1 All equipment shall meet the mandatory requirements of the National Energy Code for Buildings (NECB).
- .2 Chlorofluorocarbon (CFC)-based refrigerants shall not be used on heating, ventilating, and air conditioning and refrigeration (HVAC&R) systems.

1.6 GENERAL SAMPLE REQUIREMENTS

- .1 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Label each sample indicating their intended use
 - .3 Indicate any deviations from the Contract Documents
- .2 Submittal Procedure
 - .1 Submit one (1) sample to the Consultant at the time of Shop Drawing review or as required.
- .3 Required Samples
 - .1 Refer to the requirements of each Section.
- .4 Acceptance Criteria
 - .1 A sample shall be considered approved upon written indication by the Consultant.

1.7 GENERAL MOCK-UP REQUIREMENTS

- .1 Scope of Work
 - .1 Provide mock-ups where required by each Section.
 - .2 The approved mock-up will serve as the standard of workmanship and material that against which the work will be verified.
- .2 Review Procedure
 - .1 Prepare the mock-up to include all applicable systems that could potentially affect the acceptance of the work
 - .2 Coordinate with other trades as required to incorporate information that could potentially affect the acceptance of the work
 - .3 Make arrangements with the Consultant to review the work
 - .4 Obtain approval from the Consultant to proceed with Construction based on the quality of work demonstrated in the mock-up

- .3 Mock-Up Documentation
 - .1 Provide a written record of the mock-up review.
 - .2 Submit in accordance with the requirements of Division 01.
 - .3 File Format: Portable document format (PDF) file.
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date mock-up was demonstrated to the Consultant
 - .2 Name of people present at the demonstration
 - .2 Technical Information
 - .1 Written description of the contents of the mock-up including specific construction details
 - .2 Photographs demonstration the construction details
- .4 Submittal Procedure
 - .1 Submit one (1) complete copy to the Consultant for review no later than ten (10) working days after Consultant review of mock-up.
 - .2 Include a copy of the mock-up review in the Operation and Maintenance Manuals.
- .5 Acceptance Criteria
 - .1 The mock-up shall be considered the accepted basis of construction upon the Consultant's written acceptance.

1.8 GENERAL INFORMATION DOCUMENT REQUIREMENTS

- .1 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date the document was issued
 - .2 Name of company responsible for issuing the document including contact information for associated personnel
 - .3 Purpose of the document
 - .4 Other general information pertinent to the understanding of the document
 - .2 Technical Information
 - .1 As required based on the nature of the document
- .2 Submittal Procedure
 - .1 Submit one (1) complete copy to the Consultant for review at the time of Shop Drawing submittal.

- .2 Include a copy of the report in the Operation and Maintenance Manuals.
- .3 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Consultant's written acceptance of the documentation.

1.9 GENERAL SHOP DRAWING REQUIREMENTS

- .1 The Contractor's Responsibility with Respect to Shop Drawings
 - .1 The Contractor shall be solely responsible for ensuring that all product information contained in the Shop Drawing is completely compliant with the Contract Documents prior to submitting for the Consultant's review.
 - .1 The Contractor shall be responsible for correcting all products or materials found to be non-compliant with the requirements of the Contract Documents at such time they are discovered.
 - .2 The Contractor shall thoroughly review all Shop Drawings including those prepared by Subcontractor's, Sub-Subcontractor's, and Engineers retained by the Contractor to ensure:
 - .1 Their formatting is compliant with the Contract Document requirements
 - .2 The product information is compliant with the Contract Documents
 - .3 The materials and equipment are constructible
 - .4 Any deviances in parameters (such as dimensions, weight, electrical characteristics, performance parameters, etc.) with respect to the basis of design equipment indicated in the Drawing Schedules or specifications will not result in additional costs to other trades.
 - .5 They have been coordinated and verified that the components fit and work together in accordance with the design intent
 - .3 Where professional design services or certifications are delegated to a responsible design professional retained by the Contractor, the properly licensed responsible design professional's signature and seal shall appear on all related Shop Drawings.
 - .4 Contract Document Deviance Summary
 - .1 Should it be impossible for the Contractor, a Subcontractor, or a Supplier to provide products and materials that are compliant with the requirements of the Contract Documents, the Contractor shall prepare a Contract Document Deviance Summary Sheet and attach it to the front page of the Shop Drawing submittal.
 - .2 The Contract Document Deviance Summary shall include:
 - .1 An explanation of why it is not possible to meet the requirements of the Contract Documents with evidence supporting this claim (i.e. a letter or correspondence from the base-specified equipment supplier, etc.).
 - .2 A list of specific performance parameters/functionality that cannot be met.

- .3 A summary of the Contractor's recommended substitute products or materials.
 - .4 A written description of all pertinent changes, deviations or substitutions from the requirements of the Contract Documents.
 - .5 The Shop Drawing for the Contractor's recommended alternate product or material (from an Approved Manufacturer when possible) that best matches the performance criteria for the specified equipment that otherwise meets the requirements of the Contract Documents.
 - .6 A list of other deviations from the Contract Documents that will result of using the alternate material or equipment including, but not limited to:
 - .1 Space requirements
 - .2 Equipment weights
 - .3 Electrical parameters
 - .4 Control or functionality
 - .7 Indication as to whether the alternate product or material will have a cost implication (including that of other trades which may be affected)
 - .1 Where the alternate product is deemed to affect the cost of the work (as either a credit or an extra), the Contractor shall prepare a quotation identifying the cost impact (including all affected trades) and include it in the Shop Drawing submission.
- .2 The Consultant's review of the Shop Drawings
- .1 The purpose of the Consultant's review of the Shop Drawings is to:
 - .1 Provide a secondary review of the information provided by the Contractor to check if the specified closeout submittal requirements are met (i.e. format, type of content, maintenance requirements, etc.)
 - .2 Review supplemental information about the products and materials being provided by the Contractor to assist the Consultant in performing their Field Reviews.
 - .2 The Consultant's review of the Shop Drawings is not:
 - .1 An indication that the Shop Drawing has been reviewed by the Consultant for compliance with the Contract Documents.
 - .2 An indication that deviances of product parameters such as dimensions, quantities, weight, electrical characteristics, performance parameters, etc. are acceptable and will not result in additional costs to other trades.
 - .3 The Consultant's review of Shop Drawings that have been stamped as 'Reviewed', or 'Reviewed as Noted', that contain deviations from the Contract Document requirements, regardless of whether they were accompanied by the Contractor's Contract Document Deviance Summary, shall not be deemed as an acknowledgement or approval of the deviation.

- .4 The Consultant's review of Shop Drawings produced by a licensed professional retained by the Contractor shall be for the purpose of checking for general conformance with the design parameters provided for the purpose of defining the Design Delegate's scope of work and responsibilities in the Contract Documents.
- .5 Consultant's Shop Drawing Comments
 - .1 Shop Drawings submitted for the Consultant's review will be stamped using one of the four responses below and returned to the Contractor:
 - .1 Reviewed
 - .2 Reviewed as Noted
 - .3 Revise and Submitted
 - .4 Not Reviewed
 - .2 Shop Drawings marked as 'Reviewed' indicate that the Consultant has reviewed the information provided, but not necessarily that the information is in accordance with the Contract Documents which is the sole responsibility of the Contractor.
 - .3 Shop Drawings marked as 'Reviewed as Noted' indicate that the Consultant has reviewed the information provided, but not necessarily that the information is in accordance with the Contract Documents which is the sole responsibility of the Contractor. Shop Drawing marked as 'Reviewed as Noted' do not need to be resubmitted and are noted only to provide general comments to the Contractor such as reminders of related information contained in the Contract Documents such as site coordination that needs to take place and other general information that is not expected to affect the project cost.
 - .4 Shop Drawings marked as 'Revise and Resubmit' indicate that the Consultant happened to notice information that was not compliant with the requirements of the Contract Documents and therefore must be revised and resubmitted.
 - .5 Shop Drawings marked as 'Not Reviewed' indicate that the Consultant (or specific Sub-Consultant) does not need to review the information.
 - .6 The Contractor shall not perform any portion of the work for which Shop Drawings, mock-ups, samples or similar product data submittals are required until the respective submittal has been stamped by the Consultant as either 'Reviewed' or "Reviewed as Noted".
 - .7 Where the Consultant's review of the shop drawing or Contract Document Deviance Summary results in the need to revise the Contract Documents, the Consultant shall issue a written Change Order.
 - .1 If the Contractor believes that a comment made by the Consultant on a shop drawing marked as 'Reviewed as Noted' will result in additional costs, the Contractor shall notify the Consultant immediately.
- .3 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.

- .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
- .4 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .5 Each Shop Drawing submittal shall include a cover sheet prepared by the submitting Contractor that MUST include the following:
 - .1 Project Name
 - .2 Consultant's Project Number
 - .3 Descriptive title of the Shop Drawing
 - .4 Contractor's Shop Drawing tracking number
 - .5 Number of pages under title page
 - .6 Brief description of Shop Drawing contents (including equipment tags that match those shown on the drawings)
 - .7 Specification Section number relating to the Shop Drawing
 - .8 Name and phone number of Contractor or Sub-Contractor responsible for ensuring that the information contained in the Shop Drawing is compliant with the Contract Documents
 - .9 Name and phone number of the equipment supplier responsible for the technical details of the Shop Drawing who may be contacted by Consultant to discuss the submittal details (Providing this information may prevent the need for a Shop Drawing to be stamped as 'Revise and Resubmit')
 - .10 Contractor's stamp, signed by Contractor's authorized representative certifying review and approval of submissions, verification of field measurements and compliance with Contract Documents
 - .11 A blank area no smaller than 200 mm wide x 125 mm high for exclusive use by Consultant for stamps and review comments
- .6 Shop Drawings shall include the following general information as a minimum in addition to that required by individual Sections:
 - .1 Associated equipment tag and functional descriptor
 - .2 Installation instructions
 - .3 Manufacturer certification of current model production
 - .4 Certification of compliance to applicable codes and standards
 - .5 Required operating and maintenance clearances
 - .6 Detailed drawings of bases, supports, and anchor bolts
 - .7 Performance based on specified set-point parameters
 - .8 Electrical information including (but not limited to): voltage, phase, frequency, full-load amps, horsepower, current, and power factors.
 - .9 Weight and dimensions
- .4 Submittal Procedure

- .1 Submit one (1) copy of each Shop Drawing to the Consultant as required by each Section and for all tagged equipment on the drawings and specifications.
- .2 Thoroughly review the content of each Shop Drawing and stamp it to indicate it is compliant with the Contract Documents prior to submission to the Consultant. The Contractor's stamp indicates they have verified it is in strict accordance with the requirements of the Contract Documents.
- .3 Shop Drawings that are not submitted according to the Submittal Procedure, or not in accordance with the Submittal Format, are subject to being returned without review by Consultant. Shop Drawings that are rejected due to a failure to comply with the specification requirements shall be resubmitted allowing the full fifteen (15) working day review period from the date of the re-submittal.
 - .1 The Contractor shall be responsible for submitting Shop Drawings in accordance with the specification requirements in order to not adversely affect the Construction Schedule.
- .4 Where the Consultant has stamped Shop Drawings as 'Revise and Resubmit', make the required changes and/or provide the requested information and resubmit.
 - .1 Allow an additional ten (10) working days (as a minimum) for the Consultant to do a review of the Revise and Resubmit Shop Drawings.
 - .2 Allow sufficient time in the Construction Schedule for Shop Drawing review including sufficient time for subsequent reviews of Shop Drawings that have been noted as "Revise and Resubmit".
- .5 Consultant's Timely Review of Shop Drawings
 - .1 Allow a minimum of ten (10) working days between the date of submission to the Consultant and the requested return date for the Consultant's review.
 - .1 Shop Drawings that indicate a desired return date less than the minimum specified review duration may not be achievable and shall not be considered a construction delay caused by the Consultant if the target return date is not met.
 - .2 Refrain from submitting a large amount of Shop Drawings over a short period of time or in large groups. If this occurs, the Consultant reserves the right to indicate the required amount of time in order to do a proper review of the Shop Drawings. Adequate time for the Consultant to do a thorough review of the Shop Drawings shall be allowed for in the construction schedule and extensions to the review period shall not be deemed as an unforeseen extension to the construction schedule.

1.10 GENERAL TEST REPORT REQUIREMENTS

- .1 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:

- .1 General Information
 - .1 Date the test was performed
 - .2 Name of company performing the test including contact information for associated personnel
 - .3 Purpose of the test
 - .4 Information on equipment used for the test including records of equipment calibration
 - .5 Other general information pertinent to the understanding of the test
- .2 Technical Information
 - .1 As required based on the nature of the test
- .2 Submittal Procedure
 - .1 Submit one (1) complete copy to the Consultant for review no later than ten (10) working days after testing.
 - .2 Include a copy of the report in the Operation and Maintenance Manuals.
- .3 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Consultant's written acceptance of the documentation.

1.11 GENERAL MANUFACTURER'S EQUIPMENT START-UP REPORT REQUIREMENTS

- .1 General Requirements
 - .1 Provide a report issued by the equipment manufacturer (or authorized representative) providing a record that the equipment has been set up properly, checked for safety, and is ready to be put into operation.
 - .2 Coordinate timing of manufacturer's equipment start-up with the work of other trades.
- .2 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date the equipment set-up was performed
 - .2 Name of company performing the work and contact information for associated personnel
 - .2 Technical Information
 - .1 Content and organization in accordance with the manufacturer's standards

- .3 Submittal Procedure
 - .1 Submit one (1) complete copy to the Consultant for review no later than ten (10) working days after equipment setup.
 - .2 Include a copy of the manufacturer's equipment start up report in the Operation and Maintenance Manuals.
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Consultant's written acceptance of the documentation.

1.12 GENERAL CERTIFICATION REPORT REQUIREMENTS

- .1 General Requirements
 - .1 Provide a report issued by the recognized authority certifying the specified parameters or code requirements have been met.
- .2 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
 - .2 Indicate all parameters using metric (SI) units.
 - .3 File Format: Portable document format (PDF) file (complete with content index and embedded bookmarks based on required format Sections).
 - .4 Organize the content of the submittal as follows:
 - .1 General Information
 - .1 Date the system was reviewed by the certifying agent
 - .2 Name of company of the certifying agent and contact information for associated personnel
 - .2 Technical Information
 - .1 Description of the specific requirements that need to be met for certification
 - .2 Signature of the certifying agent stating the system is compliant with the project or code requirements
- .3 Submittal Procedure
 - .1 Submit one (1) complete copy to the Consultant for review no later than ten (10) working days after review of the certifying agent.
 - .2 Include a copy of the certification report in the Operation and Maintenance Manuals.
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Consultant's written acceptance of the documentation.

1.13 GENERAL OPERATION AND MAINTENANCE MANUAL REQUIREMENTS

- .1 General Requirements

- .1 The work of Divisions 20 through 24 shall be incorporated into the Operation and Maintenance Manual requirements of this Section.
 - .1 The Operation and Maintenance Manual shall be separate from the EMCS Operation and Maintenance Manual required by Section 25 05 01 – EMCS General Requirements.
- .2 Submit Operation and Maintenance Manuals three times throughout the duration of the project in accordance with Submittal Format below.
- .2 Submittal Format
 - .1 Submittal Content Requirements
 - .1 Submittal #1: Format Review
 - .1 Submittal Format: Indexed .pdf file
 - .2 Submittal Timeline: Submit after all information of Section 1 – Mechanical Systems has been prepared (see General Manual Format)
 - .3 Submittal Instructions: Provide placeholders for all other information not included in this submittal
 - .4 Required information:
 - .1 All formatting including cover text for each binder, wording of each tab, and directories
 - .2 All information required by Section 1 – Overview
 - .2 Submittal #2: Pre-TAB Review
 - .1 Submittal Format: Indexed .pdf file
 - .2 Submittal Timeline: Submit a minimum of 15 working days prior to commencement of TAB
 - .3 Submittal Instructions:
 - .1 Information required by any Section may be submitted at this time providing that it is complete
 - .4 Required information:
 - .1 All information from Submittal #1
 - .2 All information required by Section #2
 - .3 All information required by Section #3
 - .3 Submittal #3: Final Submission Review
 - .1 Submittal Format: Indexed .pdf file and one (1) physical copy
 - .2 Submittal Timeline: Submit after acceptance of Substantial Performance
 - .3 Submittal Instructions:
 - .1 Ensure the cover text for each binder has been approved prior to preparing the physical copies
 - .4 Required information:
 - .1 Provide all information required by this Section
 - .2 Physical Copy Assembly Requirements

- .1 Prepare using 8-1/2 x 11-inch text pages, expanding post binders with durable green-colour cloth covers connected to spine with piano hinges.
 - .2 Prepare binder cover with printed title "OPERATION AND MAINTENANCE MANUAL – MECHANICAL", title of project, and subject matter of binder when multiple binders are required.
 - .3 Internally subdivide the binder contents with permanent page dividers, logically organized as described in the format Section below; with tab titling clearly printed on reinforced laminated plastic tabs.
 - .4 Provide additional binders as required to store all the required information.
- .3 General Manual Format
- .1 Section 1 - Overview
 - .1 Index:
 - .1 Complete O&M Manual index (for all mechanical binders)
 - .2 Include this tab at the beginning of each binder when multiple binders are used
 - .2 Directory:
 - .1 Directory listing names, addresses, and telephone numbers the Consultant, all Sub-Consultants, Contractors, Subcontractors, and all equipment suppliers
 - .3 Drawings:
 - .1 List of all mechanical Contract Document Drawings
 - .2 List of all drawings produced by Design Delegates (i.e. Fire Protection Engineer, etc.)
 - .4 Description of Systems:
 - .1 Written description for each major mechanical system related to the scope of work (site services, plumbing, heating, cooling, HVAC, fire protection. controls etc.)
 - .5 Identification:
 - .1 Systems and Equipment Identification Directory required by Section 20 15 43 – Mechanical Identification
 - .2 Valve Tag Directory required by Section 20 15 43 – Mechanical Identification
 - .2 Section 2 – Tests & Reports
 - .1 Permits:
 - .1 All permits obtained for the project
 - .2 All permit inspection reports
 - .2 Manufacturer’s Equipment Start-Up Reports:
 - .1 All Manufacturer’s Equipment Start-Up Reports required by each Section
 - .3 System Test Reports:

- .1 All System Test Reports required by each Section.
- .4 Testing Adjusting & Balancing Reports:
 - .1 All TAB reports required by Section 20 30 01 – Testing, Adjusting, and Balancing
 - .2 Final operational set-points for field-adjustable devices (other than equipment controlled through the BMS)
- .5 Commissioning Reports:
 - .1 Documentation required by Section 20 30 03 – Mechanical System Commissioning
- .6 Certificates
 - .1 Declaration of Extended Warranties (where required by each Section)
 - .2 Declaration of Premium Motor Efficiencies required by Section 20 10 13 – Common Motor Requirements
 - .3 Declaration of Motor/VFD Compatibility and Warranty as required by Section 20 10 14 – Variable Speed Drives
 - .4 Seismic Hazard Review as required by Section 20 15 10 – Seismic Controls
 - .5 Seismic Engineer Assurance of Field Review and Compliance as required by Section 20 15 10 – Seismic Controls
 - .6 Fire Protection Engineer Assurance of Field Review and Compliance as required by Section 21 05 05 – Common Work Results – Fire Suppression
 - .7 Certificate of Compliance from Medical Gas Certifier
 - .8 Certificate of Compliance from the Clean Room/Fume Hood/BSC Certifier
 - .9 All ABSA Submittal Documentation required by Section 23 22 13 – Steam and Condensate Piping
- .3 Section 3 – Product Data
 - .1 Shop Drawings:
 - .1 All Shop Drawings and product data as required by each Section (separate each product with an indexed tab)
 - .2 Maintenance Data:
 - .1 Installation instructions
 - .2 Servicing, maintenance, operation, and trouble-shooting instructions for each Shop Drawing as appropriate
 - .3 Detailed schedule and description of preventive maintenance and lubrication tasks organized by the following categories: Daily, Weekly, Monthly, Semi-annually and Annually and including the tools required
 - .4 Descriptive text that provides instruction on actions to be taken in event of equipment failure

- .5 Recommended spare parts
- .6 Spare Parts Delivery Transmittal as required by this Section
- .3 System Demonstration and Training:
 - .1 System Demonstration and Training Report for mechanical systems
- .3 Submittal Procedure
 - .1 Submit Operation and Maintenance Manuals (O&Ms) three times throughout the project as follows:
 - .1 Submittal #1: Format Review
 - .2 Submittal #2: Pre-TAB Review
 - .3 Submittal #3: Final Submission Review
 - .2 Include all content from previous review submittals, including required revisions in subsequent review submittals.
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Consultant's written acceptance of the documentation.

1.14 CONTRACTOR MARKED-UP AS-BUILT DOCUMENT REQUIREMENTS

- .1 General Requirements
 - .1 Provide Contractor marked-up As-Built Drawings for **ALL** Contract Document drawings including those prepared by Design Delegate professionals (when present).
 - .1 Submit a copy of each drawing in the Contractor As-Built Document Submittal even if that drawing does not contain Contractor mark-ups.
 - .2 Contractor As-Built Documents shall be submitted separately from the EMCS Contractor As-Built Documents required by Section 25 05 01 – EMCS General Requirements.
 - .3 Accessibility
 - .1 Contractor Marked-up As-Built Drawings shall be available to the consultant for review at all times throughout Construction.
 - .4 Format during Construction
 - .1 Contractor Marked Up As-Built Drawings may be maintained in either hard-copy or digital format during construction but must be submitted digitally in accordance with the Submittal Format requirements below.
 - .5 Accuracy
 - .1 Maintain a complete set of Contractor As-Built Documents from the beginning of the Work through to its completion updating them daily as a minimum.
 - .2 Store Contractor As-Built Documents separate from other documents being used for construction.

- .3 Incorporate all changes and variances to the Contract Documents including:
 - .1 Contractor initiated changes due to site coordination
 - .2 Addenda
 - .3 Change Orders
 - .4 Site Instructions
 - .5 Instructions though Requests for Information
 - .6 Shop Drawing comments
 - .7 Product substitutions or alternates that deviate from the equipment schedules
 - .8 Sample and Mock-up comments
 - .9 Existing systems that are affected by demolition or renovation work
 - .10 Changes made as required by Manufacturer's installation instructions
 - .11 Changes made as part of Testing, Adjusting, and Balancing
 - .12 Changes made as part of System Start-up
 - .13 Changes made as part of System Commissioning
- .6 Specific Information Required
 - .1 Ensure the following specific information is clearly indicated on the Contractor As-Built Drawings:
 - .1 Measured horizontal and vertical dimensions for all underground service mains referenced to grid lines (including where services leave the building perimeter).
 - .2 All information relating to concealed conditions
 - .3 Field changes of dimension and detail
 - .4 Pertinent installation details not shown in the Contract Document Drawings
 - .5 Updated Contractor Drawing equipment schedules showing installed product details and parameters (manufacturer, model, performance parameters, capacity, etc.) data differs from the base specification shown on the Drawings
 - .6 Other specific As-Built requirements specified throughout Divisions 20 through 24
 - .7 Location of:
 - .1 Access door locations and sizes
 - .2 Submittal Format
 - .1 Contractor As-Built Documents shall be submitted in PDF format.
 - .2 Note entries in red text and deletions in blue.
 - .3 Ensure entries are clear and legible, complete, and accurate.

- .1 Contractor As-Built Drawings shall not contain notes or other markings that are not indicative of as-built conditions.
- .4 The Contractor shall mark each As-Built Drawing with a stamp in the bottom right hand corner, or in the title block, that reads, "AS-BUILT DRAWINGS AS RECORDED BY THE CONTRACTOR" (Signature of Contractor) (date) or equivalent text that indicates that the Contractor has incorporated all required information into the drawing set
- .3 Submittal Procedure
 - .1 Upon request by the Contractor, the Consultant will provide a full set of the Contract Document Drawings (excluding the drawings produced by the Fire Protection Engineer or other drawings prepared by the Contractor) in .PDF format for the Contractor's use in preparing the marked-up As-Built Drawings
 - .2 After the Work has been completed and after the deficiencies have been corrected and signed-off as complete, the Contractor shall sign and date each As-Built Drawing (including those where no changes have occurred)
 - .3 Scan the entire set of marked-up As-Built Drawings in .PDF format and submit to the Consultant for review.
 - .1 Marked-up As-Built Drawings that are submitted in an alternate format, are missing required information, are incomplete, or that do not bear the Contractor's signature and date indicating accuracy of the information, are subject to be rejected and declared incomplete.
 - .2 Incorporate comments made by the Consultant and resubmit for additional review as requested
 - .4 Include a copy of the original Contractor marked-up As-Built Drawings in the Operation and Maintenance Manuals
- .4 Acceptance Criteria
 - .1 The submittal shall be considered complete upon the Consultant's written acceptance of the documentation.

1.15 GENERAL SPARE PARTS REQUIREMENTS

- .1 General Requirements
 - .1 Prepare a Spare Parts Delivery Transmittal that identifies all the spare parts required by each Section
 - .2 Provide beside each spare part line item a signature field for the Contractor and the Owner
 - .3 Submit Spare Parts in advance of Substantial Completion
- .2 Submittal Format
 - .1 Submit in accordance with the requirements of Division 01.
- .3 Submittal Procedure
 - .1 After delivery of Spare Parts, the Contractor and the Owner's Representative shall both sign the Transmittal to indicate delivery and acceptance of the materials

- .2 Provide quantities of Spare Parts in accordance with the requirements of each Section.
- .3 Submit one (1) completed copy of the Spare Parts Delivery Transmittal to the Consultant in advance of Substantial Completion.
- .4 Insert one (1) completed copy of the Spare Parts Delivery Transmittal in the Operation and Maintenance Manuals in advance of Operation and Maintenance Manuals Review Submittal.
- .4 Acceptance Criteria
 - .1 The delivery of Spare Parts shall be considered complete upon submitting a Spare Parts Delivery Transmittal that has been signed by both the Contractor and Owner's Representative.

1.16 GENERAL SYSTEM DEMONSTRATION AND TRAINING REQUIREMENTS

- .1 General Requirements
 - .1 Provide System Demonstration and Training Report in accordance with Division 01 supplemented by the requirements of this Section
 - .2 Refer to Section 20 30 03 – Mechanical Commissioning for additional System Demonstration and Training requirements
- .2 Scope
 - .1 Provide system demonstration and training for each item of equipment and system including start-up, operation, control, adjustment, troubleshooting, servicing, and maintenance
- .3 Quality Assurance
 - .1 Provide competent instructors thoroughly familiar with the system for which demonstration and training are being provided.
 - .2 Provide training sessions that are project specific.
- .4 Timing
 - .1 Arrange for System Demonstration and Training after:
 - .1 Equipment and systems are fully operational and have been tested, adjusted, and balanced
 - .2 All sequences of operation have been verified by the Contractor to be functioning in accordance with the Contract Documents for each mode of operation
 - .2 System Demonstration and Training may be performed over the course of multiple days as required based on the amount of work required and availability of those involved.
 - .1 Where System Demonstration and Training is completed in multiple sessions, a System Demonstration and Training Report shall be provided for each session
- .5 Materials

- .1 Supply all necessary tools, equipment and personnel to facilitate complete system demonstration
- .2 Provide visual and audio equipment aids as required to perform training.
- .3 Provide each trainee with a copy of the System Demonstration and Training Plan at the start of the session as an agenda.
 - .1 Coordinate the number of trainees that will be attending in advance of training.
- .6 Execution
 - .1 The training sessions shall follow the outline in the Table of Contents of the Operation and Maintenance Manual and refer to the location of the information in the Manual for reference.
 - .2 System Demonstration and Training shall start with classroom-like sessions followed by hands-on training for each piece of equipment.
 - .1 Provide any pertinent equipment to facilitate the session including overhead projectors, slides, and video/audio material.
 - .3 If the equipment or system should fail to operate in accordance with the Contract Documents during the training session, the nature of the failure shall be noted in the System Demonstration and Training Report and the session shall be rescheduled after the issue(s) have been corrected if determined to be necessary by the Owner
 - .4 The Contractor shall determine the appropriate trade, manufacturer's representative, or combination of people who shall run each session.
 - .1 When a Commissioning Authority is present on the project, the Contractor shall coordinate with them to determine who will lead the System Demonstration and Training sessions
 - .5 Where the Contractor has used systems to maintain an environment at the worksite during the construction process, include lessons learned and information gathered on the operations of the systems
 - .6 Training topics shall include:
 - .1 A review of the written Operation and Maintenance Manuals with an emphasis on the safe and proper operating requirements, preventative maintenance, and special tools needed and spare parts inventory suggestions.
 - .2 Demonstration of start-up and operation of equipment (in all control modes), shut-down, seasonal changeover procedures and emergency procedures
 - .3 Discussion of relevant health and safety issues and concerns
 - .4 Discussion of warranties, guarantees, and emergency contact information
 - .5 Common troubleshooting problems and solutions
 - .6 Discussion of any peculiarities of equipment installation or operation

1.17 SUBSTANTIAL COMPLETION

- .1 General Requirements

- .1 The substantial completion requirements of this Section apply to the Work of Divisions 20 through 25.
- .2 The substantial completion requirements of this Section shall supplement and be read in conjunction with the substantial completion requirements of Division 01.
- .3 The substantial completion requirements of this section are not intended to identify every specific requirement for Substantial Completion, but rather to provide the Contractor with the general criteria that will be used to evaluate whether the work is substantially complete.
 - .1 The Consultant reserves the right to identify additional specific criteria for substantial completion based on the nature of the project and the risks to the Owner.
 - .2 The Contractor shall be responsible for requesting clarification of any additional substantial completion requirements in advance of the Application for Substantial Completion to ensure if there are any other specific requirements in terms of completed work before applying for Substantial Completion.
- .2 Application for Substantial Completion
 - .1 When the Contractor is of the opinion that the Work of sections 20 through 25 meets the requirements for Substantial Completion as defined by this Section and elsewhere in the Contract Documents, the Contractor shall prepare and submit to the Consultant the following:
 - .1 A statement indicating the Contractor's belief that the state of the Work meets the substantial performance requirements of this Section
 - .2 A list of *Deficient Work*, as previously identified by the Consultant, that is yet to be corrected along with a schedule of when the corrective work will take place
 - .3 A list of proposed *Deferred Work* along with a schedule of when the *Deferred Work* will take place
 - .4 A list of *Incomplete Work*
 - .2 Acceptance of the Contractor's list of *Deficient Work*, *Deferred Work*, and *Incomplete Work* shall not alter the requirements of the Contract Documents or be misconstrued as the Consultant's acceptance that work not identified is accepted as complete or in accordance with the Contract Documents.
 - .3 The Contractor shall allow a minimum of 10 working days after the Application for Substantial Completion for the Consultant to review the application documents against the substantial completion requirements, perform a final field review of the work, and to prepare a written response for the Application.
 - .1 If rejection of the Application for Substantial Completion could negatively impact pre-determined occupancy, partial occupancy, or other scheduled dates that are critical to the Contractor or Owner, the Contractor shall be responsible for incorporating additional time into the construction schedule to allow for a proper Substantial Completion application and review process based on the complexity of the work and importance of the project deadlines.

- .3 The work shall be considered Substantially Complete when all the following general and specific requirements have been met:
 - .1 General requirements:
 - .1 The products of the work are *Ready for the Purpose Intended* as determined by the Consultant.
 - .2 *Deficient Work* is minor (in the opinion of the Consultant) and may be corrected safely and with minimal disruption to building operations and occupants after the work is turned over.
 - .3 *Deferred Work* (including post-occupancy TAB and/or commissioning) has been identified by the Contractor in writing and collectively agreed to be treated as such by the Owner, Consultant, and Contractor.
 - .4 There is no *Incomplete Work* in the opinion of the Consultant.
 - .5 Substantial Completion requirements identified in other specification Sections have been satisfied.
 - .6 The Consultant has indicated in writing that the work is deemed to be substantially complete.
 - .2 Specific Requirements for Substantial Completion
 - .1 As a minimum, the following must be complete prior to application for Substantial Completion
 - .1 All work relating to building code requirements is complete and all related closeout documents have been submitted and accepted as complete by the Consultant.
 - .2 All work relating to life-safety is complete and all related closeout documents have been submitted and accepted as complete by the Consultant.
 - .3 All work relating to start-up, testing, adjusting, and balancing is complete and all related closeout documents have been submitted and accepted as complete by the Consultant.
 - .4 All work relating to commissioning is complete and all related closeout documents have been submitted and accepted as complete by the Consultant.
 - .5 All Contractor Marked-Up As-Built Document Requirements have been submitted and accepted as complete by the Consultant.
 - .6 The Final Submission Review of the Operation and Maintenance Manuals has been submitted and accepted as complete by the Consultant.

1.18 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment required in Division 20 through Division 25 Sections

1.19 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Certification Reports
 - .1 Contractor's Declaration of Warranty
 - .2 Information Documents
 - .1 System Demonstration and Training Plan
 - .2 System Demonstration and Training Report
 - .3 Record of Service Work
 - .3 Operation and Maintenance Manuals Content
 - .1 Operation and Maintenance Manuals requirements where specified in Division 20 through Division 25 Sections
 - .4 Contractor As-Built Markups Content
 - .1 Contractor As-Built Markup requirements where specified in Division 20 through Division 25 Sections
 - .5 Spare Parts
 - .1 Spare parts requirements where specified in Division 20 through Division 25 Sections

1.20 CONTRACTOR'S DECLARATION OF WARRANTY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Division 0 supplemented by the requirements of this Section.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a signed statement indicating full warranty for the Work and equipment provided by the Contractor and the Contractor's Sub-Contractors in accordance with the warranty requirements specified in Division 0 or a required by the specifications of Divisions 20 through 25.
 - .2 Submittal Format
 - .1 Include the following:
 - .1 Approved date of Substantial Performance
 - .2 Description of all work and equipment covered by the warranty
 - .3 Warranty end date
 - .4 Name of the Contractor Company carrying the warranty
 - .5 Name and signature of the Contractor's employee having authority to warranty the work
 - .6 Where Extended Warranties are required, provide a clear description of the applicable systems or equipment the Extended Warranty applies to
 - .3 Submittal Procedure

- .1 Include a copy of all Declaration of Warranties in the Operation and Maintenance Manual.

1.21 SYSTEM DEMONSTRATION AND TRAINING PLAN

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a written plan describing the details of the System Demonstration and Training execution.
 - .2 Submittal Format
 - .1 Organize the System Demonstration and Training Plan as follows:
 - .1 Desired date of training (coordinated by the Contractor with other training activities)
 - .2 Training Agenda: Detailed list of topics that will be discussed during training session(s)
 - .3 Sample sign-in sheet
 - .4 List of visual/audio aids that will be used for training
 - .5 Names of training personnel
 - .6 Description of representative Owner staff from facilities who should be present for the training
 - .3 Submittal Procedure
 - .1 Submit one (1) copy to the Consultant for review a minimum of fifteen (15) working days prior to the first planned training session date.
 - .2 Schedule System Demonstration and Training during regular work hours or at alternate times approved by the Owner
 - .3 Make any revisions to the System Demonstration and Training Plan as required by the Consultant or the Owner for resubmission prior to performing system demonstration and training.

1.22 SYSTEM DEMONSTRATION AND TRAINING REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a report showing that System Demonstration and Training has been completed satisfactorily to the Owner.
 - .2 Submittal Format
 - .1 Organize the System Demonstration and Training Plan as follows:

- .1 The format and training agenda shall be in accordance with the HVAC Commissioning Process, ASHRAE Guideline 1-1989R, 1996 are an equivalent standard
 - .2 The date and time the training took place
 - .3 Name of training personnel
 - .4 The agenda for the training session updated to include any other important topics discussed
 - .5 A copy of the sign-in sheet indicating each person who was present (including the Owner, Contractor, and Commissioning Lead representatives as applicable)
 - .6 A list of any materials that have (or will be) turned over to the Owner to supplement the training session (videos, literature, etc.)
 - .7 Lessons learned and information gathered on the operations of the systems used to maintain an environment at the worksite during the construction phase
 - .8 Any supplemental information requested to be inserted into the Operation and Maintenance Manuals during the session
 - .9 A statement prepared by the Contractor, signed by both the Contractor and Owner, indicating that the training session has been satisfactorily completed
- .3 Submittal Procedure
- .1 Submit one (1) copy to the Consultant for review no later than ten (10) working days after the date of each training session.
 - .2 Insert one (1) complete copy of the final System and Demonstration and Training Report in the Operation and Maintenance Manuals.
- .3 Acceptance Criteria:
- .1 System Demonstration and Training shall be considered complete upon submission of the signed statement of completion signed by the Owner for each of the training sessions indicated in the System Demonstration and Training Plan.

1.23 RECORD OF SERVICE WORK

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a record of service work for each service call request made during the warranty period.
 - .2 Submittal Format
 - .1 Each time service work is performed, record the following:
 - .1 Date and time service call request was made by the Owner

- .2 Date and time service call was first responded to by the service company
 - .3 Name of Service Company and personnel assigned to the service call
 - .4 Description of the system behavior prompting a service call request
 - .5 Description of the specific equipment or components requiring maintenance
 - .6 Description of the work required to be performed to resolve the service request
 - .7 Summary of material and time spent required to resolve the service request
 - .8 Time and date of service call completion
- .3 Submittal Procedure
- .1 Consolidate all Records of Service Work one month before the end of the warranty period and provide to the Owner for inclusion in the Operations and Maintenance Manual

Part 2 Products

2.1 ACCESS DOORS

- .1 In general, access doors are not typically indicated on the mechanical drawings due to potential variances with the installed equipment locations and those shown on the drawings.
 - .1 Provide access doors in accordance with this Section and where required for equipment access, in addition to the locations shown on the drawings.
- .2 Indicate the locations of all access doors on the Contractor marked-up As-Built Drawings.
- .3 Sizes
 - .1 Except where otherwise indicated, the minimum sizes shall be as follows:
 - .1 For body entry: 600 x 600 mm.
 - .2 For hand entry: 300 x 300 mm.
- .4 Construction
 - .1 Rounded safety corners (except fire rated doors), concealed hinges, screwdriver latch, anchor straps, and able to open 180 degrees
 - .2 Fire rating: ULC listed to suit wall or ceiling assembly
 - .3 Security access doors: construction per standard doors except with tamper-proof security cam latches using allen head with center-pin. Provide where indicated
- .5 Materials
 - .1 Standard access doors
 - .1 300x300 mm size: 16ga door, 18ga frame

- .2 600x600 mm size: 14ga door, 16ga frame
- .2 Fire-rated access doors:
 - .1 Material construction as per ULC listing
- .3 Security access doors:
 - .1 12ga door, 12ga frame
- .6 Finish
 - .1 Tiled or marble surfaces and other special areas: Stainless steel with brushed satin or polished finish as directed by Consultant.
 - .2 Wet areas: aluminum or stainless steel construction (areas such as showers, PCC decontamination etc.).
 - .3 All other areas: Prime coated baked enamel steel.

Part 3 Execution

3.1 EQUIPMENT ACCESS

- .1 Access for Maintenance
 - .1 Coordinate the timing of the work with other trades to ensure that the minimum required maintenance space (for servicing, lubrication, disassembly, and removal of equipment or components) is maintained.
 - .1 The Contractor shall be responsible for remedial work required where the work of one Sub-Contractor infringes on the required access space for equipment due to inadequate coordination or planning
 - .2 The required access area for maintenance shall be the greater value between the minimum dimensions recommended by the manufacturer, dimensions indicated on the drawings, or dimensions required by the specifications.
 - .1 Regardless of published minimum requirements for maintenance access, coordinate and install the systems so that equipment can be maintained in a safe manner.
 - .2 The Consultant (along with the Owner's representative) reserves the right to determine if equipment can be maintained in a safe manner.
- .2 Access Doors
 - .1 Supply and install access doors for all concealed mechanical equipment requiring maintenance (supplemented by locations shown on the plan drawings) to suit site conditions to enable access for operating, inspecting, adjusting, and servicing.
 - .2 Access doors are not required in lay-in tile ceilings. Provide Above-Ceiling Equipment Markers in accordance with Section 20 15 43 – Mechanical Identification.
 - .3 Ensure that equipment requiring maintenance is clearly within view and is easily reachable for operating, inspecting, adjusting, and servicing without the need for special tools or removal of obstructing equipment.

3.2 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store, and handle materials in accordance with the manufacturer's requirements, and that of Division 01.
- .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with the manufacturer's recommendations in clean, dry, well-ventilated area
 - .2 Store and protect materials from nicks, scratches, and blemishes
 - .3 Replace defective or damaged materials with new

3.3 PAINTING

- .1 Provide painting in accordance with the requirements of Division 09.
- .2 Apply a minimum of one coat of corrosion resistant primer paint to all ferrous supports and site fabricated equipment.
- .3 Provide system identification in accordance with the requirements of Section 20 15 43 – Mechanical Identification.

3.4 REPAIRS AND RESTORATION

- .1 Restore finishes that have been damaged throughout the course of construction to new condition.

3.5 CLEANLINESS

- .1 Clean the construction site daily in accordance with the requirements of Division 01.
- .2 Cleanliness During Construction:
 - .1 Clean concealed areas (i.e. above ceiling spaces) as required to maintain dust-free surfaces on equipment and services
- .3 Final Cleaning:
 - .1 Clean the exterior surfaces of all equipment
 - .2 Clean the interior surfaces of all equipment with maintenance access doors or panels
 - .3 Replace all filters with new media
 - .4 Clean all strainers in piped systems

3.6 WASTE MANAGEMENT

- .1 Remove, store, or reuse construction waste in accordance with the requirements of Division 01.

3.7 ELECTRICAL WORK

- .1 Provide electrical work in accordance with the requirements of Division 26 supplemented by the requirements of each Section.

- .2 All control wiring to conform to the requirements of Division 26 including conduit, wiring and connections below 50 V that are related to control systems specified in Division 25 and/or shown on mechanical drawings.
- .3 Refer to Division 26 for the quality of materials and workmanship requirements.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA)
 - .1 CSA Z317.13, Infection Control During Construction, Renovation, and Maintenance of Healthcare Facilities

1.2 GENERAL REQUIREMENTS

- .1 Perform demolition and renovation work in accordance with this Section and the requirements of Division 01 and Division 02.
- .2 Cease work and notify the Departmental Representative and Owner immediately if hazardous materials are discovered during the work (other than those previously identified).
- .3 Take precautions to protect existing equipment from being damaged
 - .1 The Contractor shall be responsible for remedial work to repair damage caused to existing equipment to remain.
- .4 Where demolition is required, completely remove all associated materials and equipment including piping, ducting, wiring, tubing, supports, controls, etc. unless indicated otherwise.
- .5 Confirm piping is completely drained prior to demolition.

1.3 HANDLING OF DEMOLISHED MATERIALS IDENTIFIED FOR REUSE OR TURN-OVER TO THE OWNER

- .1 Where materials or equipment have been identified for reuse, carefully remove, store, and protect them in accordance with the requirements of Division 01.
- .2 Where materials or equipment have been identified for turn-over to the Owner, carefully remove them, and turn over to the Owner in accordance with the requirements of Division 01.
- .3 The pressure differential between the construction areas and adjacent areas shall be maintained as negative throughout the course of construction.

1.4 RENOVATION WORK IN AN OCCUPIED OR PARTIALLY OCCUPIED BUILDING

- .1 The boundary of the mechanical renovation work is not necessarily limited to the general area of renovations identified by a zone boundary on the plan drawings.
 - .1 Affected services may pass through occupied areas outside of the renovation zone boundary including on floors above or below the general renovation area, or where the source equipment is located.
- .2 Where mechanical systems serve other occupied areas of the building that need to remain operational during the work, provide a Service Interruption Strategy Report.

1.5 PHASED RENOVATIONS OF MECHANICAL SYSTEMS

- .1 Perform phased renovations of mechanical systems in accordance with the phasing requirements of Division 01.
- .2 The Contractor shall bear and include all costs associated with the safe execution of the phased work without adversely affecting the operation or environmental conditions of other occupied areas of the building. These costs may include provision of temporary services not explicitly defined in the Contract Documents, system by-passes, temporary equipment, or other work required in order to execute the work.

1.6 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Existing Condition Site Survey
 - .2 Service Interruption Strategy Report

1.7 EXISTING CONDITION SITE SURVEY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Conduct a site review of the existing mechanical equipment to identify any variances between actual conditions and information shown on the drawings illustrating existing systems
 - .2 Submittal Format
 - .1 Mark up a copy of the drawings or provide a list of all deviations or conditions that will affect the cost of the work for the work specified
 - .2 Provide supplemental drawings, sketches, or pictures to illustrate the conditions

1.8 SERVICE INTERRUPTION STRATEGY REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
 - .2 Do not shut down any mechanical services until approved by the Owner or the Authority Having Jurisdiction (for life-safety services).
 - .1 Coordinate service shut-downs with the Owner each time prior to completing the work
 - .3 Coordinate the Service Interruption Strategy for all life safety systems with the Departmental Representative, the Fire Protection Engineer, and the Authority Having Jurisdiction.
- .2 Specific Requirements

- .1 Scope of Work
 - .1 Where demolition work is required in an occupied or partially occupied building and the work affects the services of these spaces, provide a detailed overview of the strategy proposed for ensuring continuous operation of non-renovated areas during temporary service shut-downs.
- .2 Submittal Format
 - .1 Indicate the following:
 - .1 A description of the systems which will be affected by the work
 - .2 Strategies for maintaining service of mechanical systems to areas outside of the renovation boundary (i.e. isolation valves that will be closed, temporary services required, etc.)
 - .3 The planned /requested date(s) of the shut-down
 - .4 The expected duration the system or service will be shut-down
 - .5 Identify any unknown factors that may pose a risk for being able to provide continuous service for occupied areas
 - .6 Where phased renovations are required, provide strategies for each phase
 - .7 Valve tag numbers of isolation valves that are required to be closed during the service shut-down
 - .8 Measures that will be taken to ensure the safety of the building occupants during the shut-down period
- .3 Submittal Procedure
 - .1 Revise the proposed strategies as required to suit the requirements of the Owner.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Provide all materials and equipment as required to perform the work of this Section.

Part 3 Execution

3.1 SELECTIVE DEMOLITION IN OCCUPIED BUILDINGS

- .1 Perform demolition in occupied (or partially occupied) buildings in accordance with the requirements of Division 01.
- .2 Strictly follow the Owner's standards and guidelines for construction and demolition in an occupied when provided.
- .3 Remove, store, or reuse construction waste in accordance with Division 01.

3.2 WORK SCHEDULE

- .1 Perform work during times in accordance with the requirements of Division 01 and Division 02.

.2

Work may be suspended at any time at the Owner's Representative discretion due to safety issues or work adversely affecting the occupied areas of the building.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1, Power Piping
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated
 - .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
 - .3 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture
 - .2 MSS SP69, Pipe Hangers and Supports - Selection and Application
 - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices
- .4 National Research Council Canada (NRCC)
 - .1 National Plumbing Code of Canada (NPC)

1.2 DESIGN REQUIREMENTS

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
- .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 in accordance with MSS SP58.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.4 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.

.2 Specific Requirements

- .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 01 – Common Work Results – Mechanical indicate the following:
 - .1 Any applicable load calculations

1.5 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.6 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.7 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 00 1 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of:
 - .1 Housekeeping pads (including dimensions)
 - .2 Floor-mounted structural supports for overhead pipe/equipment racks

Part 2 Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with the following:
 - .1 MSS SP58
 - .2 ANSI B31.1
 - .3 SMACNA Seismic Restraint Manual
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 PIPE HANGERS

- .1 Finishes:

- .1 Pipe hangers and supports unless otherwise noted: Galvanized, zinc-plated, cadmium-plated, or prime plated
- .2 Ensure steel hangers in contact with copper piping are copper-plated or epoxy coated
- .2 Upper attachment structural:
 - .1 To SMACNA Seismic Restraint Manual
- .3 Upper attachment to concrete:
 - .1 To SMACNA Seismic Restraint Manual
- .4 Shop and field-fabricated assemblies:
 - .1 To SMACNA Seismic Restraint Manual
- .5 Hanger rods: threaded rod material to MSS SP58 and SMACNA Seismic Restraint Manual:
 - .1 Ensure that hanger rods are subject to tensile loading only
- .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized
 - .2 Attachments for copper piping: copper plated black steel
 - .3 Use insulation shields for pipework
 - .4 Oversize pipe hangers and supports
- .7 Adjustable clevis: material to MSS SP69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: cadmium plated or prime plated
 - .2 Finishes for copper, glass, brass or aluminum pipe work: black, with formed portion plastic coated
- .10 Pipe rollers
 - .1 Finish: Malleable iron or cast iron
 - .2 Material: Cast iron roll and roll stand with carbon steel rod to MSS SP69
 - .3 Refer to 20 20 30 – Piping and Equipment Insulation for shield or saddle requirements

2.3 RISER CLAMPS

- .1 Steel or cast iron pipe: cadmium plated or prime painted carbon steel to MSS SP58, type 42.
- .2 Copper pipe: carbon steel copper plated or epoxy coated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

- .1 Refer to 20 20 30 – Piping and Equipment Insulation for requirements on insulated piping.

2.5 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2springs 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.

2.7 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Division 05.
- .2 Submit calculations with shop drawings.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Division 05.
- .2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with the 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 pipe is 13 mm or more
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted
- .7 Use variable support spring hangers for first four hangar points on piping connected with flexible connections to vibration isolated equipment.

3.3 HANGER SPACING

- .1 Plumbing piping: to the most stringent requirements of the Authority Having Jurisdiction, Provincial Code, and the National Plumbing Code of Canada.
- .2 Copper piping: up to NPS 1/2: every 1.5 m.
- .3 Within 300 mm of each elbow.
- .4 Space hangers for copper and steel pipe in accordance with the following table:

Pipe Size: NPS	Maximum Spacing (m)	Rod diameter (mm)
up to 1-1/4	2.4	10
1-1/2	2.4	10
2	3.0	10
2-1/2	3.0	10

Pipe Size: NPS	Maximum Spacing (m)	Rod diameter (mm)
3	3.6	10
4	3.6	12
6	4.3	16
8	4.3	16
10	4.3	20
12	4.3	20
14	6.1	25
16	6.1	25
18	6.1	25

- .5 Pipework greater than NPS 12: to MSS SP69.
- .6 Space hangers for plastic piping in accordance with pipe manufacturers installation recommendations.

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.
- .4 Double-nut all attachments to hanger rods for piping over NPS ¾.

3.5 PIPE 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 13mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.
- .3 Where horizontal pipe movement is between 13 mm and 25 mm , ensure that hanger length is at least 300mm long, use adjustable clevis hangers, offset pipe hanger and support so that rod hanger is vertical in the hot position.
- .4 Where horizontal pipe movement is greater than 25 mm, use pipe roller supports.
- .5 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
- .6 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical
 - .2 Variation in supporting effect does not exceed 25% of total load

3.6 PIPING SUPPORTS IN SHAFTS – PIPING SUBJECT TO THERMAL EXPANSION

- .1 Applicable piping systems:

- .1 Hot water heating
- .2 Glycol heating
- .2 Anchor piping at mid height of shaft
- .3 Support piping at top of shaft using constant support spring hangers immediately at top of vertical piping risers and at each of three horizontal hanger locations away from top of shaft.

3.7 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

3.8 TESTING – THERMAL EXPANSION COMPENSATION DEVICES

- .1 General Requirements
 - .1 Verify expansion compensation ability under extreme initial and design conditions (temperature & flow).

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 National Research Council Canada (NRCC)
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 24.3 – Standards for Pipe Identification
- .3 Workplace Hazardous Materials Information System (WHMIS)

1.2 EXISTING IDENTIFICATION SYSTEMS

- .1 When modifying a portion of an existing system, provide identification that matches that of the existing otherwise provide identification in accordance with the requirements of this section.

1.3 PIPING IDENTIFICATION SYSTEMS GOVERNED BY CODES AND STANDARDS

- .1 Where identification of systems are governed by Codes or specified to be in accordance with a specific Standard, the requirements of those Codes or Standards shall take precedence over the requirements of this section.

1.4 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Systems and Equipment Identification Directory
 - .2 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.5 SYSTEMS AND EQUIPMENT IDENTIFICATION DIRECTORY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 10 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a directory showing the nomenclature used for all mechanical system and service identification.
 - .2 Submittal Format
 - .1 List of all tagged equipment (on both the drawings and specifications) with the following:
 - .1 Short description of equipment function
 - .2 Equipment tag number that will appear on the nameplates

- .3 Description of the equipment location
- .2 List of all piping and ductwork system with the following:
 - .1 Short description of system function
 - .2 The following identification information for each system:
 - .1 The label identification nomenclature
 - .2 The symbols that will be used (flow arrow, etc.)
 - .3 Actual dimensions of text and arrows
 - .4 Identification colors/banding etc.
 - .3 Provide a reduced scale, color drawing showing a typical example sample of:
 - .1 An equipment nameplate
 - .2 The actual identification of a distribution system as it will appear as applied on site
 - .3 Sample of above-ceiling equipment markers that will be used

1.6 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.

1.7 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.8 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.9 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of all tagged equipment provided in the specifications but not already shown on the plan drawings

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers to be raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: Manufacturer's name, model, size, serial number, capacity
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size

2.2 LAMINATED PLASTIC NAMEPLATES

- .1 Colours:
 - .1 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 Lettering Sizes:
 - .1 Terminal cabinets, control panels: 8 mm high lettering
 - .2 Equipment in Mechanical Rooms or Outdoors: 20 mm high lettering
 - .3 Equipment located elsewhere: 12 mm high lettering

2.3 COMBINATION BALANCING VALVE / FLOW METERS

- .1 Metal identification tag attached with chain containing the following:
 - .1 Design flow rates
 - .2 Meter readings for design flow rates
 - .3 Metered fluid
 - .4 Line size
 - .5 Tag number
 - .6 Station or location number

2.4 ABOVE-CEILING EQUIPMENT MARKERS

- .1 Description: Self-adhesive plastic coated paper dots, 15 mm diameter, colour coded, applied to t-bar grid or access door.
- .2 Colour code as follows:
 - .1 Yellow - HVAC equipment
 - .2 Red - Fire dampers/smoke dampers
 - .3 Green - Plumbing valves and cleanouts
 - .4 Blue - Heating/cooling valves

2.5 PIPING AND DUCTING SYSTEMS IDENTIFICATION

- .1 Stencils: With clean cut symbols and letters of following size:
 - .1 20-30 mm Outside Diameter of Insulation or Pipe: 15 mm high letters
 - .2 40-50 mm Outside Diameter of Insulation or Pipe: 20 mm high letters
 - .3 65-150 mm Outside Diameter of Insulation or Pipe: 30 mm high letters
 - .4 Over 150mm Outside Diameter of Insulation or Pipe: 65 mm high letters
 - .5 Ductwork and Equipment: 65 mm high letters
 - .6 Flow arrowhead height to match letter height
- .2 Stencil Paint: Semi-gloss enamel, black color
- .3 Identify contents by legend and pictogram (where required) and direction of flow by arrows using stencilled painted markings.
- .4 Pictograms:
 - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations
 - .2 Including:
 - .1 Radiation hazard.
 - .2 Biohazard.
- .5 Legend:
 - .1 Block capital letters
- .6 Arrows showing direction of flow:
 - .1 Use double-headed arrows where flow is reversible
- .7 Legends:
 - .1 Where not listed, obtain direction from Consultant
 - .2 Legends for piping systems:

Background Color	Legend Arrows
Yellow	Black
Green	White
Blue	White
Red	White

- .8 Background color marking and legends for piping systems (based on General Paint Custom Colors)

System	Paint Code No.	Color	Legend
HEATING SYSTEM			
Hot Water Supply	4815-A	Dark Orange	HWS
Hot Water Return	4095-D	Light Orange	HWR
Glycol Supply	4220-D	Dark Pink	GLYS
Glycol Return	4220-D	Dark Pink	GLYR
Condensate Return	4010-D	Light Yellow	COND
Boiler Feed Water	4168-W	Petal Pink	BFW

2.6 VALVE IDENTIFICATION

- .1 Valve Tags: tags with 12 mm high lettering and brass jack chain for fastening to valve. Following types of valve tags are acceptable:
- .1 Brass tags: 40 mm diameter.
 - .2 Plastic tags: 50 mm x 50 mm
 - .3 Anodized aluminum tags: 40 mm diameter

2.7 BUILDING AUTOMATION SYSTEM (BAS) IDENTIFICATION

- .1 BAS Identification Tags: 0.75 mm thick plastic laminated tags imprinted with tag label information with brass jack chain for attachment to device. Include following minimum information on point tag label:
- .1 Logical Point Name
 - .2 Point Multiplexer Address
 - .3 Associated System Identification
 - .4 Point Description
- .2 BAS Laminated Directories: permanently mounted, laminated directories:
- .1 BAS Equipment Panel Directory: show locations of each transducer, actuator or other piece of equipment in panel
 - .2 BAS Wiring Panel Directory: in each panel where control wiring terminates, provide a cross-reference listing between key name, descriptors, hardware address and numbered tape markings on wiring

Part 3 Execution

3.1 GENERAL INSTALLATION

- .1 Submit samples of identification system for consultant and owner review prior to installation.
- .2 Provide identification only after all painting has been completed.
- .3 Provide ULC or CSA registration plates as required by respective agency.
- .4 Identify all equipment listed on equipment schedules on drawings and specifications with laminated plastic nameplates.

3.2 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 in any way

3.3 PIPING AND DUCTWORK IDENTIFICATION SYSTEMS

- .1 Apply piping and ducting identification systems to all piping and ducting except piping or ducting that is located in non-accessible chases and furred-in spaces. Apply identification to all piping and ducting in ceiling spaces.
- .2 Locate piping and ducting identification as follows:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: At not more than 15m 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 (1.5 sq. m or less) through which piping or ductwork passes
 - .4 On both sides of visual obstruction or where run is difficult to follow
 - .5 On both sides of separations such as walls, floors, partitions
 - .6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening
 - .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, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side

- .3 Identification shall be easily observable from normal operating areas and maintenance access locations.
 - .1 Position of identification to be 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

3.4 VALVES, CONTROLLERS

- .1 Tag all valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.5 ABOVE-CEILING EQUIPMENT MARKERS

- .1 Provide markers in T-bar type ceilings to identify locations of all dampers, valves, cleanouts and equipment located above T-bar type ceilings.
- .2 Locate marker on T-bar closest to equipment.
- .3 Locate marker on access doors in drywall ceilings.

3.6 BUILDING AUTOMATION SYSTEM (BAS) IDENTIFICATION

- .1 Use BAS mnemonics specified in BAS specification sections on tags and nameplates to identify BAS physical points and equipment.
- .2 Identify the following BAS output controls and input sensor devices with BAS Identification Tags:
 - .1 Field points
 - .2 Sensors
 - .3 Actuators
 - .4 Devices
- .3 Identify the following BAS components with Laminated Plastic Nameplates:
 - .1 Remote control unit (RCU) panels
 - .2 Subpanels
 - .3 Associated equipment panels
 - .4 Panel mounted valves; identify function of each valve

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

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

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.3 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Test Reports
 - .1 Pipe Pressure Test Reports
 - .2 Pipe Cleaning Report
 - .2 Operation and Maintenance Manuals Content
 - .3 Contractor As-Built Markups Content

1.5 PIPE PRESSURE TEST REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a pipe pressure test report for the following piped systems:
 - .1 Hydronic piping
 - .2 Conditions of Test
 - .1 Isolate equipment and other system components not rated to withstand the testing pressure
 - .3 Performance Requirements
 - .1 Perform pressure test at a minimum of 150% or the intended system operating pressure

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

1.6 PIPE CLEANING REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a pipe cleaning report for the following piped systems:
 - .1 Hydronic piping

1.7 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.8 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of
 - .1 Piping not shown on plan drawings including vent and drain piping

Part 2 Products

2.1 MATERIAL

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
- .2 Sealants: in accordance with Division 07.
- .3 Fire Stopping: in accordance with Division 07.

2.2 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.

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

2.3 DRAIN VALVES

- .1 NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.

2.4 MANUAL AIR VENTS

- .1 Ball valve and plug.

2.5 SLEEVES

- .1 Where sleeves pass through:
 - .1 Mechanical room floors: schedule 40 black steel pipe
 - .2 All other locations: galvanized steel ductwork

2.6 DIELECTRIC COUPLINGS

- .1 Compatible with system, to suit pressure rating of system.
- .2 Construction:
 - .1 NPS 2 and under: brass adapters or bronze valves
 - .2 Over NPS 2: isolating flanges

2.7 VALVES

- .1 Refer to Section 20 20 09 – Valves – Hydronic Systems.

2.8 ESCUTCHEONS

- .1 One piece type with set screws.
- .2 Chrome or nickel plated brass or type 302 stainless steel.

Part 3 Execution

3.1 CONNECTING TO EXISTING PIPED SYSTEMS

- .1 Connect into existing piping systems in accordance with Section 20 05 02 – Mechanical Work in Occupied Buildings.

3.2 COORDINATION WITH EMCS TRADE

- .1 Coordinate work with EMCS contractor (refer to Division 25). EMCS contractor shall provide control valves, meters, sensors, etc. for installation by the mechanical contractor. Coordinate and cooperate with EMCS contractor for location of all sensing ports and requirements.

3.3 PIPEWORK INSTALLATION

- .1 Support piping in accordance with Section 20 15 19 – Bases, Hangers and Supports.
- .2 Screwed fittings jointed with Teflon tape.

- .3 Protect openings against entry of foreign material.
- .4 Install so that equipment can be isolated and removed without interruption of any other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may not be used.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework so as to minimize furring space, maximize headroom, conserve space.
- .9 Except where indicated otherwise, slope piping in direction of flow for positive drainage and venting.
- .10 Except where indicated, install so as 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 and specified.

3.4 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other systems, equipment, components.

3.5 DRAINS

- .1 Install piping with grade in direction of flow except as indicated or specified otherwise.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

3.6 AIR VENTS

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

3.7 SLEEVES

- .1 Provide sleeves in the following locations:
 - .1 All penetrations through floors
 - .2 All penetrations through masonry walls
 - .3 All penetrations through fire rated walls where required by fire-stopping system
- .2 Use annular fins continuously welded at mid-point at:
 - .1 Foundation walls
 - .2 Where sleeves extend above finished floors

- .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .4 Provide 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Sleeve Termination:
 - .1 Through mechanical room floors: 25 mm above finished floor
 - .2 Through interstitial space floors: 25 mm above finished floor
 - .3 Other floors or walls: terminate flush with finished surface
- .6 Sealant:
 - .1 Foundation walls: LinkSeal.
 - .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 suitable as firestopping.
 - .4 Ensure no contact between copper pipe or tube and sleeve

3.8 DIELECTRIC COUPLINGS

- .1 Locations: where dissimilar metals are joined.

3.9 VALVES

- .1 Refer to Section 20 20 09 – Valves – Hydronic Systems.

3.10 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Sizes:
 - .1 Outside diameter to cover opening or sleeve
 - .2 Inside diameter to fit around pipe or outside of insulation if so provided

3.11 PREPARATION FOR FIRE STOPPING

- .1 Refer to Division 07.

3.12 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush piped systems in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.13 TESTING – PIPED SYSTEMS

- .1 Refer to Section 20 30 02 – Mechanical System Testing.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
 - .2 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch)
- .2 American Society for Testing and Materials (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 A276, Specification for Stainless and Heat Resisting Steel Bars and Shapes
 - .4 ASTM B61, Specification for Steam or Valve Bronze Castings
 - .5 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings
 - .6 ASTM B85, Specification for Aluminum-Alloy Die Castings
 - .7 ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - .8 ASTM B283, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed)
 - .9 ASTM B505, Specification for Copper-Base Alloy Continuous Castings
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions
 - .2 SP 67, Butterfly Valves
 - .3 SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends
 - .4 SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends
 - .5 SP-80, Bronze Gate Globe, Angle and Check Valves
 - .6 SP-82, Valve Pressure Testing Methods
 - .7 SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
 - .8 SP-110, Ball Valves, Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 ULC C-267-B.

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.3 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Information Documents
 - .1 Valve Tag Directory
 - .2 Operation and Maintenance Manuals Content
 - .3 Contractor As-Built Markups Content
 - .1 All valve locations that differ from where shown on the Drawings
 - .2 All valves required by the specifications and not shown on the Drawings

1.5 VALVE TAG DIRECTORY

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a valve tag directory for all hydronic valves
 - .2 Submittal Format
 - .1 Include following information in the directory:
 - .1 Valve number
 - .2 Location
 - .3 Service
 - .4 Make/model size
 - .5 With/without hand-wheel
 - .6 Type of control
 - .7 Normal position
 - .8 Flow diagram showing the location of the valve schematically

1.6 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section into the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.7 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements

- .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Balanced flow rates of balancing valves
 - .2 Location of:
 - .1 Isolation valves in service spaces, shafts, and ceiling spaces

Part 2 Products

2.1 GENERAL

- .1 Valves of each style for each service to be supplied by single manufacturer.
- .2 Valves for high pressure steam service to have CRN registration numbers.

2.2 END CONNECTIONS

- .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends.
 - .2 Copper tube systems: Solder ends.

2.3 LOCKSHIELD KEYS

- .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

2.4 GATE VALVES

- .1 Requirements common to all gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: with hex. shoulders.
 - .3 Connections: with hex. shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous. Nut: bronze to ASTM B62.
- .2 NPS 2 and under, non-rising stem:
 - .1 Class 125, Bronze body, bronze trim, screwed inside or union bonnet, rising stem, handwheel, inside screw with backseating stem, solid wedge disc, alloy seat rings, threaded ends.
- .3 Over NPS 2 – rising stem:
 - .1 Class 125, iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

- .4 Over NPS 2 – non-rising stem:
 - .1 Class 125, iron body, bronze trim, bolted bonnet, non-rising stem, handwheel, solid wedge disc with bronze seat rings, flanged ends.

2.5 GLOBE VALVES

- .1 Requirements common to all globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: with hex. shoulders.
 - .3 Connections: with hex. shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous. Nut: bronze to ASTM B62.
- .2 NPS 2 and under:
 - .1 Bronze body, bronze trim, union or screwed bonnet, rising stem and handwheel, inside screw with backseating stem, renewable PTFE composition disc and bronze seat, threaded ends.
- .3 Over NPS 2:
 - .1 Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.

2.6 BALL VALVES

- .1 Acceptable manufacturers:
- .2 Requirements common to all ball valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-110.
 - .2 Body and cap: cast high tensile bronze to ASTM B62.
 - .3 Pressure rating: Class125, 860 kPa steam, WP = 1.4 MPa WOG.
 - .4 Connections: Screwed ends to ANSI B1.20.1 and with hex. shoulders or solder ends.
 - .5 Stem: brass or bronze with tamperproof ball drive.
 - .6 Stem packing nut: external to body.
 - .7 Ball and seat: full port replaceable chrome plated brass solid ball and teflon seats.
 - .8 Stem seal: TFE with external packing nut.
 - .9 Operator: removable lever handle.

2.7 PLUG VALVES

- .1 Up to 50 mm:
 - .1 Cast iron body and plug, full port opening, pressure lubricated, Teflon packing, threaded ends.
 - .2 Operator: Each plug valve with a wrench with set screw.

- .2 Over 50 mm:
 - .1 Cast iron body and plug, full port opening, pressure lubricated, Teflon packing, flanged ends.
 - .2 Operator: Each plug valve with a wrench with set screw.

2.8 BUTTERFLY VALVES

- .1 Body: Cast or ductile iron with resilient replaceable EPDM seat, lug ends, extended neck.
- .2 Disc: Aluminum bronze.
- .3 Stem: type 416 stainless steel
- .4 Operator: Multi-position lever handle up to 150mm; hand wheel and gear drive over 150mm.

2.9 SWING CHECK VALVES

- .1 Up To and including 50 mm:
 - .1 Class 125 bronze body, bronze trim, bronze rotating swing disc, with Teflon composition disc, solder or threaded ends
- .2 Over 50 mm:
 - .1 Class 125 iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends

2.10 SILENT CHECK VALVES

- .1 Up To and including 50 mm:
 - .1 Iron body, bronze trim, in-line wafer style with stainless steel spring, bronze disc and seat, wafer ends
- .2 Over 50 mm:
 - .1 Iron body, bronze trim, in-line globe style with stainless steel spring, bronze disc and seat, lug ends

2.11 COMBINATION BALANCING VALVE / FLOW METER

- .1 Flow measuring element: calibrated Venturi, accuracy +/- 1%, pitot tubes with quick disconnect gauge fittings and brass shut off valves.
- .2 Balancing valve:
 - .1 Up to NPS 2: brass body, NPT connections chrome-plated brass ball, PTFE seat and stem seals, memory locking lever handle
 - .2 Over NPS 2: Ductile iron body, flanged connection, chrome plated ball, PTFE seat and stem seals, memory locking lever handle
- .3 Rated to min 1380 kPa operating pressure at 120°C fluid temperature.
- .4 Refer to Section 20 15 43 –Identification for valve tag requirements.
- .5 Acceptable material: Bell & Gossett Venturi MV Series

Part 3 Execution

3.1 INSTALLATION

- .1 General Requirements
 - .1 Solder in accordance with manufacturer's instructions.
 - .2 Install rising stem valves in upright position with stem above horizontal.
 - .3 Install in accordance with manufacturer's recommendations.

3.2 ACCESSIBILITY

- .1 Install valves in locations that are fully accessible, can be replaced in the future, and can be maintained in a safe manner.
 - .1 Coordinate valve locations on site with all trades and their respective building services to ensure it is optimally located for accessibility after construction is complete.
 - .2 Coordination of valve locations shall occur prior to installation of building services to ensure that accessibility is not compromised due to the subsequent work of another trade after the valve has been installed.
- .2 A valve that meets any of the following criteria shall be considered inaccessible:
 - .1 Does not meet the Manufacturer's minimum accessibility requirements
 - .2 Not fully visible from where it will be maintained
 - .3 Requires removal of other piping, conduit, equipment, or other building elements in order maintain or replace it
 - .4 Would result in an unsafe condition for facility operators to maintain or replace it

3.3 IDENTIFICATION

- .1 Refer to section 20 15 13 – Identification for identification requirements for concealed valves located above ceilings.

3.4 VALVE LOCATIONS

- .1 Provide valves where required by the specifications in addition to where shown on the Drawings.
- .2 Balancing Valves
 - .1 Install balancing valves in the following locations:
 - .1 Where indicated on the drawings
 - .2 In the bypass around all control valves
- .3 Isolation Valves
 - .1 Install isolation valves in the following locations for all hydronic systems including but not limited to potable water, non-potable water, soft water, heating water, chilled water, and condenser water:
 - .1 At the bottom of each riser shaft (either inside or outside the shaft depending on the shafts size and accessibility)

- .2 Where piping passes through a shaft wall (either inside or outside the shaft depending on the shafts size and accessibility)
- .3 Where pipes leave mechanical rooms (located within the mechanical room)
- .4 At the main distribution branch serving a floor, zone, or department
- .5 At all branch take-offs
- .6 At junction branches
- .7 At branches serving separate buildings
- .8 Where the pipe service mains (or supply and return pipe mains) enter the building
- .9 At equipment
 - .1 All equipment shall be connection with either a union or a flange in addition to the isolation valve.
 - .2 Install equipment isolation valves within 1m of the device (fixture, terminal equipment, source equipment, owner supplied equipment, etc.) unless otherwise indicated.
 - .3 Provide supply and return isolation valves where equipment have both supply and return pipe connections
- .10 At plumbing fixtures
- .11 Where indicated on the Drawings
- .2 In addition to other valve location requirements, provide isolation valves in the following locations within healthcare facilities
 - .1 On domestic cold water, domestic hot water, and domestic hot water recirc. branch piping serving each rooms/area.
 - .1 Do not provide route piping such that a single isolation valve serves multiple rooms/areas unless indicated as such on the Drawings.
 - .2 Locate the room isolation valve in the ceiling above the corridor in an accessible location.
- .4 Check Valves
 - .1 Install silent check valves in the following locations:
 - .1 On the discharge of pumps
 - .2 On vertical pipes with upward flow
 - .3 Where indicated on the Drawings
 - .2 Install swing check valves in the following locations:
 - .1 Where indicated on the drawings
 - .2 In horizontal lines
- .5 Butterfly Valves
 - .1 Between weld neck flanges to ensure full compression of liner
 - .2 Where indicated on the Drawings

3.5 VALVE TYPES

- .1 Provide valves in accordance with the Valve Type Schedule.
- .2 Valve Type Schedule:

Service	Valve Type
Equipment Isolation	Ball (1), Butterfly (3), or Gate (2)
Vertical Riser Isolation	Ball (1), Butterfly (3), or Gate (2)
Branch Line Isolation	Ball (1), Butterfly (3), or Gate (2)
Air Vent Isolation	Ball
Terminal Heat Transfer Unit Isolation	Ball
Equipment Drains	Ball with hose bibb and cap
Riser Drains	Ball with hose bibb and cap
Terminal Heat Transfer Zone Drains	Ball with hose bibb and cap
Strainer Blowdown Drains	Ball with hose bibb and cap
Pump Discharge Check Valves	Silent check
Vertical Piping Check Valves	Silent check
Other Check Valve Locations	Silent check
Balancing	Combination balancing valve / flow meter
Control Valve Bypass	Eccentric plug or Globe

Notes:

- (1) – For valves 50mm and smaller
- (2) – For valves over 50 mm in mechanical rooms, use rising stem valves. Use non-rising stem valves outside of mechanical rooms.
- (3) – Butterfly valves approved on all services except steam.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Movement and Control Association International, Inc. (AMCA)
 - .1 ANSI/AMCA Standard 204-05 (R2012), Balance Quality and Vibration Levels for Fans
- .2 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE Standard 111, Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
- .3 National Environmental Balancing Bureau (NEBB)
 - .1 NEBB Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Systems Testing, Adjusting, and Balancing

1.2 ABBREVIATIONS

- .1 AABC – Associated Air Balance Council
- .2 TAB – Testing, adjusting, and balancing
- .3 TAB Agency – An independent entity certified to perform testing and balancing work.
- .4 TABB – Testing, Adjusting, and Balancing Bureau
- .5 NEBB – National Environmental Balancing Bureau

1.3 GENERAL REQUIREMENTS

- .1 Intent
 - .1 The general intent of testing, adjusting, and balancing (TAB) is to:
 - .1 Verify proper and safe operation
 - .2 Determine actual point of performance
 - .3 Evaluate qualitative and quantitative performance of equipment and systems
 - .4 Adjust and regulate equipment and systems to meet specified performance requirements under normal, emergency, and special control mode conditions
 - .5 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges
- .2 Coordination:
 - .1 Schedule TAB (including verification and re-verification) into project construction schedule to ensure that TAB has been verified as complete well in advance of Substantial Completion

- .2 Perform TAB of each system independently unless interlocked with other systems
- .3 Operation of Systems for TAB During Construction:
 - .1 Refer to 20 05 01 - Use of Mechanical Systems During Construction
 - .2 Operate systems for length of time required for TAB and as that required for TAB verification
- .4 Special TAB Considerations:
 - .1 Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations
- .5 Commissioning:
 - .1 Perform TAB and provide required reports independently from any commissioning exercises
 - .2 The Tab Agency shall cooperate with the Commissioning Agent and perform the required services in accordance with the requirements of Division 01

1.4 QUALITY ASSURANCE

- .1 Qualifications of the Tab Agency
 - .1 TAB shall be performed by one of the following TAB Agencies:
 - .1 Enviro-Metrics Technical Services Ltd.
 - .2 Hydro-Air Technical Services
 - .3 Perfection Aire Ltd.
- .2 TAB Procedures
 - .1 TAB of systems and equipment that are regulated by codes shall be to the satisfaction of Authority Having Jurisdiction.
 - .2 Perform TAB in accordance with the following Standards supplemented by the procedures defined by this Section:
 - .1 *ANSI/ASHRAE Standard 111, Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems and its associated addenda and errata.*
 - .3 TAB procedures and submittal documentation shall be performed in accordance with the standards defined by the applicable TAB association and *ANSI/ASHRAE Standard 111, Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.*
 - .4 Where TAB of systems or system components are not covered by standard TAB procedures or defined by Section, the TAB Agency shall develop and document an appropriate procedure and include it in the Pre-TAB Report.
- .3 Measurement Accuracy Tolerances
 - .1 Calibration:
 - .1 Calibration of instruments shall be in accordance with the TAB association procedures

- .2 Accuracy of Measurement Tool and Measurements:
 - .1 Air and Water Flow Rates: $\pm 2\%$ of actual values
 - .2 Pressure Differentials: Capable of measuring to at least two decimal places
 - .3 Door Forces: Capable of measuring forces of at least 90 lbs
- .4 Performance Accuracy Tolerances
 - .1 Provide TAB as required in order to achieve design performance values within the following tolerances:
 - .1 Heating/cooling Water Flow Rates: $\pm 10\%$
 - .2 Refrigeration Systems: $\pm 10\%$
- .5 Where required room/space pressure differentials are required, the pressure differential shall have priority over airflow tolerances.

1.5 REQUIRED TAB DOCUMENTATION AND MEASUREMENTS

- .1 The following defines the required TAB data and measurements for inclusion in the TAB Report.
- .2 Where multiple items of equipment run in parallel during normal operation (air-handling units, pumps, fans, etc.), but have control sequences that require them to run independently during certain modes, provide all required TAB data for both modes of operation.
- .3 General Data Requirements
 - .1 Provide the following TAB data for each item of equipment with an equipment tag:
 - .1 Equipment Tag
 - .2 Equipment Location
 - .3 Equipment Manufacturer
 - .4 Equipment Model Number
 - .5 Equipment Serial Number
 - .6 Date TAB was performed
 - .2 Provide the following TAB data for each item of equipment than has an electrical motor:
 - .1 Frame Size
 - .2 Nameplate horsepower rating
 - .3 Actual brake horsepower
 - .4 Nameplate and measured voltage (each phase)
 - .5 Phase, and frequency
 - .6 Nameplate and measured amperage (each phase)
 - .7 Motor RPM
 - .8 Heater size
 - .9 Service factor

- .10 Starter size and thermal protection rating
- .11 Sheave make/size/bore
- .12 Motors Driven By Variable-Frequency Controllers: Test the manual bypass of the controller to prove proper operation.
- .4 Hydronic System Data Requirements
 - .1 Provide the following TAB data:
 - .1 Control Valves:
 - .1 K-factor
 - .2 Flow Balancing Valves (refer to plan drawings for locations):
 - .1 Design and balanced flow rate
 - .2 Actual pressure drop
 - .3 Valve calibrated setting at balanced flow rate
 - .4 Actual temperature at the time of measurement
 - .3 Hydronic Boilers:
 - .1 Design and actual flow rate
 - .2 Design and actual entering fluid temperature
 - .3 Design and actual leaving fluid temperature
 - .4 Design and actual pressure drop
 - .5 Fluid medium (i.e. water, glycol percentage and type)
 - .4 Pumps:
 - .1 Design and actual flow rate
 - .2 Design and actual RPM
 - .3 Impeller size
 - .4 Actual suction pressure (no flow)
 - .5 Actual discharge pressure (no flow)
 - .6 Actual suction pressure (full flow)
 - .7 Actual discharge pressure (full flow)
 - .8 Actual total head (no flow)
 - .9 Design and actual total head (full flow)
 - .10 Pump curve showing operating point and OP efficiency
 - .11 VFD-Controlled Pumps: Actual pressure sensor location marked on the plan drawings
 - .12 VFD-Controlled Pumps: Design and actual static pressure sensor setpoint used for pump control
 - .13 Motor data

1.6 TAB OF EXISTING SYSTEMS

- .1 Perform a pre-construction site review of existing equipment that is identified to remain and be reused.
 - .1 Measure and record the operating speed, airflow, and static pressure of each fan

- .2 Measure motor voltage and amperage. Compare the values to motor nameplate information
- .3 Check the condition of filters
- .4 Check the condition of coils
- .5 Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies
- .2 Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - .1 New filters are installed
 - .2 Coils are clean and fins combed
 - .3 Drain pans are clean
 - .4 Fans are clean
 - .5 Deficiencies noted in the preconstruction report are corrected
- .3 Balance system to design airflows indicated.

1.7 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Pre-TAB Execution Report

1.8 PRE-TAB EXECUTION REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a report identifying procedures that will be used for the execution of each Closeout Submittal of this Section.
 - .2 Submittal Format
 - .1 TAB Qualifications
 - .1 TAB association membership certifications for the TAB Agency
 - .2 Documentation of successful experience of personnel performing TAB
 - .3 Names of all personnel performing TAB
 - .4 TAB association membership certifications for the personnel performing TAB
 - .2 TAB Schedule
 - .1 Anticipated start of TAB
 - .2 Anticipated completion date of TAB

- .3 Scheduled date of Post-Occupancy TAB
- .3 Strategies and Procedures
 - .1 A listing of equipment and systems that will undergo TAB (as required by the Required TAB Documentation and Measurements)
 - .2 A description of the standard procedures used by the applicable TAB Standard
 - .3 Additional TAB procedures developed by the TAB Agency for systems or system components without previously established TAB Standards
 - .4 Sample TAB forms showing the format the required TAB Data will appear in
- .4 Instrumentation
 - .1 A description of the instrumentation that will be used for TAB

1.9 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Test Reports
 - .1 TAB Report
 - .2 Post-Occupancy TAB Report
 - .2 Operation and Maintenance Manuals Content
 - .3 Contractor As-Built Markups Content

1.10 TAB REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide a TAB report containing a complete record of all final parameter set-point for all equipment requiring TAB
 - .2 Submittal Format
 - .1 Title Page:
 - .1 TAB Agency name
 - .2 TAB Agency address
 - .3 TAB Agency contact information
 - .4 Project name
 - .5 Project location
 - .6 Project Architect
 - .7 Project Engineer
 - .8 Project Contractor

- .9 Project altitude
- .10 Report date
- .2 Table of Contents
- .3 Performance Guaranty:
 - .1 Certification Statement
 - .2 Name, signature, and certification numbered of applicable TAB Agency membership
- .4 General TAB Overview:
 - .1 Description of test conditions at the time of TAB
 - .2 Description of the procedures used to perform TAB
 - .3 Notable characteristics of system
 - .4 A list of items or issues that do not meet design tolerances with information that may be considered for resolving the deficiencies
- .5 Instrument List:
 - .1 Instrument type
 - .2 Instrument manufacturer
 - .3 Instrument model number
 - .4 Instrument serial number
 - .5 Instrument range
 - .6 Instrument calibration date
- .6 Required TAB Documentation and Measurements
- .3 Submittal Procedure
 - .1 Do not submit in-progress TAB reports unless requested by the Consultant.
- .4 Verification
 - .1 After TAB is complete and accurately documented in the TAB Report, arrange for verification of the data.
 - .2 The TAB Agency shall conduct the verification in the presence of:
 - .1 The Consultant
 - .2 The Authority Having Jurisdiction (for all life-safety systems)
 - .3 The Commissioning Agent
 - .3 If emergency power has been provided for the operation of any item of equipment, verification shall be conducted on both normal and emergency power.
 - .4 The Consultant shall select specific TAB data for verification of accuracy of reported values.
 - .5 Selected data shall be limited to the extent of measurements that can be verified over 8-hours.
 - .6 If the verified measurements differ from those documented in the TAB Report by more than the permitted tolerances, the verification measurement shall be noted as "FAILED."

- .7 If the number of "FAILED" verification measurements is greater than 10 percent of the total measurements checked during verification, the TAB shall be considered incomplete.
- .5 Re-verification
 - .1 If TAB is incomplete due to failed verification of data:
 - .1 The TAB Agency shall:
 - .1 Recheck all measurements and make adjustments as required to complete and correct the TAB
 - .2 Update the TAB Report with the new values, and
 - .3 Resubmit the TAB Report and request a second verification.
 - .2 Bear costs to repeat TAB verification as required until complete.

1.11 COMPLETION OF TAB

- .1 TAB shall be considered complete when:
 - .1 The Pre-TAB Report is complete and has been submitted
 - .2 The TAB Report is complete and has been completed
 - .3 The Post-Occupancy TAB Report is complete and has been submitted
 - .4 All required TAB data has been provided

Part 2 Products

2.1 SECTION NOT USED

Part 3 Execution

3.1 GENERAL TAB PROCEDURES

- .1 Timing of TAB:
 - .1 Perform TAB activities in accordance with the standard construction activity timeline as indicated by the applicable TAB association
 - .2 Provide adequate time within the Construction schedule to perform TAB allowing for multiple TAB exercises as required in order to meet the specified performance parameters
- .2 Coordination of TAB:
 - .1 Coordinate TAB activities with the work of other Divisions
 - .2 Coordinate TAB activities with the Commissioning Agent
- .3 Pre-TAB Requirements:
 - .1 Systems Perform TAB after:
 - .1 Mechanical systems are completely installed and equipment start-up has been performed

- .2 Electrical systems are complete including testing of emergency power
- .3 Confirming that the building envelope and pressure-controlled room/areas is sealed and tested
- .4 Controls and programming are complete and tested (including controller workstation graphics)
- .5 Ducted systems have been cleaned with leakage confirmed to be within specified tolerances
- .6 Piped systems have been flushed, filled, vented, and chemically treated
- .7 After verifying that balancing devices such as test ports, gauge cocks, flow-control devices balancing valves and fittings, and manual volume dampers are installed, and that their locations are accessible and appropriate for effective balancing
- .2 Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to perform TAB
- .3 Identify any deficiencies that would prevent proper completion of the TAB work prior to performing TAB
- .4 Post-TAB Requirements:
 - .1 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings
 - .2 Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings
- .5 TAB of Systems with Equipment that Operate In Parallel and in Tandem:
 - .1 Where systems contain multiple items of equipment for full or partial backup (i.e. pumps, fans, air-handling units, etc), that operate in parallel and in tandem under normal operation:
 - .1 Perform TAB for normal operation (with multiple units running)
 - .2 Perform TAB separately for each individual item of equipment operating alone
 - .2 Provide separate TAB data for multiple-unit operation as well as stand-alone operation for each item of equipment

3.2 TAB OF HYDRONIC SYSTEMS

- .1 Flow Rate Measurements:
 - .1 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance
 - .2 Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system
- .2 Flow Balancing:

- .1 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing
- .2 Perform balancing by measurement of temperature differential in conjunction with air balancing
- .3 Effect system balance with automatic control valves fully open to heat transfer elements
- .4 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings
- .5 Do not use service or shut-off valves for balancing unless indexed for balance point
- .6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Standard for Testing Materials (ASTM)
 - .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
 - .2 ASTM A105/A105M, Standard Specification for Carbon Steel Forgings, for Piping Applications

1.2 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section

1.3 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 01 – Common Work Results – Mechanical indicate the following:
 - .1 Pressure and temperature rating
 - .2 Displacement compensation (axial, lateral, angular) including the maximum rated displacement in each direction
 - .3 Nominal size and dimensions
 - .4 Details of construction and assembly

1.4 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Operation and Maintenance Manuals Content
 - .2 Contractor As-Built Markups Content

1.5 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section in to the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.6 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 Location of:
 - .1 Expansion loops showing anchor points and guides dimensioned from gridlines

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Section 01 47 15 Sustainable Requirements: Construction.

2.2 SLIP TYPE EXPANSION JOINTS

- .1 Application: for axial pipe movement, as indicated.
- .2 Repacking: under full line pressure.
- .3 Body and packing housings: Class 150, 1MPa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with flanges to match pipe.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: 6 [minimum], PTFE impregnated non-asbestos.
- .9 Thermal plastic packing: PTFE impregnated non-asbestos slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
 - .1 Plunger body: heavy wall carbon steel welded to body.
 - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.

- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug.

2.3 BELLOWS TYPE EXPANSION JOINTS

- .1 For axial, lateral or angular movements, as indicated.
- .2 Maximum operating pressure: as indicated.
- .3 Maximum operating temperature: as indicated.
- .4 Type A: free flexing, factory tested to 1 ½ times maximum working pressure. Provide test certificates.
- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1 ½ times maximum working pressure. Provide test certificates.
- .6 Reinforcing or control rings:
 - .1 2 piece nickel iron.
- .7 Ends:
 - .1 Flanges to match pipe.
- .8 Liner:
 - .1 Austenitic stainless steel in direction of flow.
- .9 Shroud:
 - .1 Carbon steel, painted.

2.4 GROOVED END EXPANSION JOINTS

- .1 Packless, Gasketed, Slip, Expansion Joints:
 - .1 2413 kPa maximum working pressure.
 - .2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.
 - .3 PTFE modified polyphenylene sulfide coated slide section.
 - .4 Suitable for axial end movement to 75 mm.
- .2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

2.5 FLEXIBLE CONNECTION

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated.
- .3 Inner hose: [tainless steel corrugated.
- .4 Diameter and type of end connection: as indicated.
- .5 Operating conditions:

- .1 Working pressure: As Indicated
- .2 Working temperature: As Indicated
- .3 To match system requirements.
- .6 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

2.6 ANCHORS AND GUIDES

- .1 Alignment guides:
 - .1 Provide as indicated.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers, jackets to remain uninterrupted.

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 INSTALLATION

- .1 Install expansion joints with cold setting, as instructed by Departmental Representative. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.
- .4 Do welding in accordance with section 23 05 17- Pipe Welding.

3.3 PIPE CLEANING AND START-UP

- .1 In accordance with Section 23 08 02- Cleaning and Start-up of Mechanical Piping Systems.

3.4 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01- Performance Verification: Mechanical Piping Systems.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1, Power Piping
 - .2 ANSI/ASME B31.3, Process Piping
 - .3 ANSI/ASME Boiler and Pressure Vessel Code:
 - .1 BPVC 2007 Section I, Power Boilers
 - .2 BPVC 2007 Section V, Non-destructive Examination
 - .3 BPVC 2007 Section IX, Welding and Brazing Qualifications
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206, Field Welding of Steel Water Pipe
- .3 American Welding Society (AWS)
 - .1 AWS C1.1M/C1.1000, Recommended Practices for Resistance Welding
 - .2 AWS Z49.1, Safety in Welding, Cutting and Allied Process
 - .3 AWS W1, Welding Inspection Handbook
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-48.2, Spot Radiography of Welded Butt Joints in Ferrous Materials
- .5 Canadian Standards Association (CSA International)
 - .1 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum
 - .2 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding
 - .3 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code
 - .4 CSA-W117.2, Safety in Welding, Cutting and Allied Processes
 - .5 CSA W178.1, Certification of Welding Inspection Organizations
 - .6 CSA W178.2, Certification of Welding Inspectors

1.2 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Welders:
 - .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 Each welder to possess identification symbol issued by authority having jurisdiction.

- .4 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
 - .1 Inspectors qualified to CSA W178.2.
- .3 Certifications:
 - .1 Registration of welding procedures in accordance with CSA B51.
 - .2 Copy of welding procedures available for inspection.
 - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Qualifications of Welding Contractor

1.4 QUALIFICATIONS OF WELDING CONTRACTOR

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide evidence of the Welding Contractor’s qualifications and compliance with the requirements of this Section.
 - .2 Submittal Format
 - .1 Include
 - .1 Copy of the welder’s certifications to perform the work
 - .2 Information on at least three projects where the Contractor has performed work of similar scope

1.5 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Test Reports
 - .1 Welding Inspection and Test Report
 - .2 Operation and Maintenance Manuals Content

1.6 WELDING INSPECTION AND TEST REPORT

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.

Part 2 Products

2.1 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

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 QUALITY OF WORK

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Divisions 20 through 25 applicable requirements of provincial authority having jurisdiction.

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Consultant before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Consultant.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General
 - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant.

- .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .3 Inspect and test 10% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests and spot full gamma ray radiographic (hereinafter referred to as "radiography") tests.
- .2 Hydrostatically test welds to requirements of ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Consultant of total of up to 10 % of welds, selected at random by Consultant by radiographic particle tests.
- .5 Full radiographic tests for piping systems.
 - .1 Spot radiography to CAN/CGSB-48.2.
 - .1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Consultant from welds which would be most difficult to repair in event of failure after system is operational.
 - .2 Radiographic film:
 - .1 Identify each radiographic film with date, location, name of welder, and submit to Consultant. Replace film if rejected because of poor quality.
 - .3 Interpretation of radiographic films:
 - .1 By qualified radiographer.
 - .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fails tests.
- .6 Magnetic particle tests for piping systems.

3.6 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, chilled water systems:
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8mm.
 - .5 Repair cracks and defects in excess of 0.8mm in depth.
 - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic particle tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard)
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate [Metric]
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement
 - .5 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547, Mineral Fiber Pipe Insulation
 - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
 - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
- .3 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
- .4 Department of Justice Canada (DJUSCs)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004)
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies

- .2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering
- .3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings
- .4 CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines

1.2 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.

1.3 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 datasheet in accordance with Section 01 33 00- Submittal Procedures . Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00- Submittal Procedures.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00- Submittal Procedures.
 - .1 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in Saskatchewan, Canada.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00- Submittal Procedures .
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00- Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available [1] copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards and member of TIAC.
- .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06- Health and Safety Requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with 20 00 01 – Common Work Results - Mechanical.
- .2 Operations and Maintenance Manuals
 - .1 Include the following documentation in the Operations and Maintenance Manuals as required by Section 20 00 01 – Common Work Results – Mechanical (in addition to the general requirements of that section).
 - .1 Shop Drawings
 - .1 Provide Contractor and Consultant-reviewed Shop Drawings for each product of this section.
 - .2 Maintenance Data
 - .1 Provide Manufacturer’s start-up, installation, and troubleshooting instructions for each product of this section
 - .2 Provide a list of spare parts recommended by the Manufacturer for each product of this section.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Section 01 47 15- Sustainable Requirements: Construction.

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 C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

- .1 Mineral fibre: to CAN/ULC-S702 & ASTM C547.
- .2 Maximum "k" factor: to CAN/ULC-S702.

2.4 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
 - .2 Provide in accordance with 20 07 15 - Thermal Insulation for Piping.
- .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 SP69.
 - .2 Provide in accordance with 20 07 15 - Thermal Insulation for Piping.

2.5 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.

2.6 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Air drying mineral wool, to ASTM C449/C449M.

2.7 VAPOUR RETARDER LAP ADHESIVE

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

2.8 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.9 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.10 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint.
 - .3 Minimum service temperatures: -20 degrees C.

- .4 Maximum service temperature: 65 degrees C.
- .5 Moisture vapour transmission: 0.02 perm.
- .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .7 Special requirements:
 - .1 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 degrees C.
 - .4 Maximum service temperature: 82 degrees 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/m²cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
- .4 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: smooth.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, [0.5]mm thick at 300 mm spacing.
- .5 Stainless steel:
 - .1 Type: 304.
 - .2 Thickness: 0.25 mm.
 - .3 Finish: smooth.

- .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
- .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

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 PRE-INSTALLATION REQUIREMENT

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 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: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: PVC

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 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.

Applica-tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
Run out			to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Boiler Feed Water		[A-1]	25	25	25	25	25
Hot Water Heating	60 - 94	[A-1]	25	38	38	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25	25	38
Glycol Heating	60 - 94	[A-1]	25	38	38	38	38
Glycol Heating	up to 59	[A-1]	25	25	25	25	38

- .4 Finishes:
 - .1 Exposed indoors: canvas jacket].
 - .2 Exposed in mechanical rooms: PVC jacket.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
 - .5 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Section 01 47 17- Sustainable Requirements: Contractor's Verification, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.

- .7 Certified wood.
- .8 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch)
 - .2 ASME B31.1, Power Piping
 - .1 ANSI/ASME B16.3, Malleable-Iron Threaded Fittings, (Classes 150 and 300)
 - .2 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings
 - .3 ANSI/ASME B16.9, Factory-Made Wrought Buttwelding Fittings
 - .4 ANSI/ASME B16.15, Cast Bronze Threaded Fittings
 - .5 ANSI/ASME B16.18, Cast Copper Alloy, Solder Joint Pressure Fittings
 - .6 ANSI/ASME B16.22, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings
 - .7 ANSI/ASME B31.9, Building Services Piping
 - .8 ASME Section IX, Welding and Brazing Qualifications
- .2 American Society of Testing Materials (ASTM)
 - .1 ASTM A47/A47M, Specification for Ferritic Malleable Iron Castings
 - .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
 - .3 ASTM A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications
 - .4 ASTM A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service
 - .5 ASTM A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
 - .6 ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service
 - .7 ASTM A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - .8 ASTM A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
 - .9 ASTM A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
 - .10 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
 - .11 ASTM A536, Standard Specification for Ductile Iron Castings
 - .12 ASTM B32 - Solder Metal
 - .13 ASTM B61, Standard Specification for Steam or Valve Bronze Castings
 - .14 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings

- .15 ASTM B88, Seamless Copper Water Tube
- .16 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols
- .17 ASTM F876, Crosslinked Polyethylene (PEX) Tubing
- .18 ASTM F877, Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems
- .3 Canadian Standards Association (CSA)
 - .1 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)

1.2 CERTIFICATES

- .1 Obtain data form for new pressure vessels, including heat exchangers, chillers, boilers, tanks from manufacture and submit data form and fee at own expense to authority having jurisdiction for certificate for pressure vessels.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide the following Action and Information Submittals:
 - .1 Information Documents
 - .1 Hydronic Pipe Flushing & Cleaning Procedure Plan
 - .2 Shop Drawings
 - .1 Shop drawings for all equipment indicated in this Section including:
 - .1 Buried piping drawings

1.4 HYDRONIC PIPE FLUSHING AND CLEANING PROCEDURE PLAN

- .1 General Requirements
 - .1 Submit in accordance with the General Information Document Requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Submit a report providing details on the Contractor's strategy for flushing and cleaning the hydronic piping.
 - .2 The report shall account for the operational impact to the facility and the ability to isolate pipe segments.
 - .2 Submittal Format
 - .1 Include the following information in addition to that required by the General Information Document Requirements defined in Section 20 00 01 – Common Work Results – Mechanical for Information Documents.
 - .1 Cleaning procedures including flow rates and duration of procedure.

- .2 Chemicals and concentrations to be used.
- .3 Inhibitors and concentrations.
- .4 Specific requirements for completion of work.
- .5 Special precautions for protecting piping system materials and components.
- .6 Complete analysis of water to be used. This is to ensure water being used will not damage systems or equipment.
- .7 Isolation valves that will be closed during the procedure.
- .3 Submittal Timing
 - .1 Submit report a minimum of 20 working days in advance of the intended pipe flushing and cleaning date.

1.5 SHOP DRAWINGS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general Shop Drawing requirements indicated in Section 20 00 01 – Common Work Results – Mechanical indicate the following:
 - .1 Joining procedures
 - .2 Hanging and support methods
 - .3 Prefabricated sections with field connection points
 - .4 Expansion joints, anchors and guides
 - .5 Expansion loops, anchors and guides
 - .6 Vents
 - .7 Drains
 - .8 Grooved joint couplings and fittings

1.6 CLOSEOUT SUBMITTALS

- .1 Provide the following Closeout Submittals:
 - .1 Test Reports
 - .1 Hydronic Pipe Pressure Test Reports
 - .2 Hydronic Pipe Flushing and Cleaning Reports
 - .2 Operation and Maintenance Manuals Content
 - .3 Contractor As-Built Markups Content

1.7 HYDRONIC PIPE PRESSURE TEST REPORT

- .1 General Requirements

- .1 Submit in accordance with the General Test Report Requirements of Section 20 00 01 – Common Work Results – Mechanical and Section 20 30 01 – Mechanical System Start-Up and Testing.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide Hydronic Pipe Pressure Test Reports that provide evidence for the successful execution of the work described in this Section.
 - .2 Systems requiring testing include:
 - .1 Glycol Heating Water System
 - .2 Submittal Format
 - .1 As per the General Test Report Requirements of Section 20 00 01 – Common Work Results – Mechanical.
 - .3 Submittal Procedure
 - .1 Submit after all hydronic pipe pressure testing has been successfully executed.

1.8 HYDRONIC PIPE FLUSHING AND CLEANING REPORT

- .1 General Requirements
 - .1 Submit in accordance with the General Test Report Requirements of Section 20 00 01 – Common Work Results – Mechanical and Section 20 30 01 – Mechanical System Start-Up and Testing.
- .2 Specific Requirements
 - .1 Scope of Work
 - .1 Provide Hydronic Pipe Flushing and Cleaning Reports that provide evidence for the successful execution of the work described in the Hydronic Pipe Flushing and Cleaning Procedure Plan.
 - .2 Systems requiring testing include:
 - .1 Glycol Heating Water System
 - .2 Submittal Format
 - .1 As per the General Test Report Requirements of Section 20 00 01 – Common Work Results – Mechanical.
 - .3 Submittal Procedure
 - .1 Submit after all pipe flushing and cleaning has been successfully executed.

1.9 OPERATION AND MAINTENANCE MANUALS

- .1 General Requirements
 - .1 Incorporate the requirements of this Section into the Operation and Maintenance Manuals in accordance with Section 20 00 01 – Common Work Results - Mechanical.

1.10 CONTRACTOR AS-BUILT DOCUMENTS

- .1 General Requirements
 - .1 Submit in accordance with the requirements of Section 20 00 01 – Common Work Results - Mechanical.
- .2 Specific Requirements
 - .1 In addition to the general requirements for Contractor As-Built Documents Markups indicated in Section 20 001 0 - Common Work Results - Mechanical, indicate the following:
 - .1 General:
 - .1 Grade direction
 - .2 Elevations
 - .2 Location of:
 - .1 Access points
 - .2 Permanent provisions for temporary instrumentation
 - .3 Valves
 - .3 Routing of:
 - .1 Vent pipes
 - .2 Drain piping

1.11 REGULATORY REQUIREMENTS

- .1 Conform to CSA B51 and ANSI/ASME B31.9 codes for installation of piping system.
- .2 Welding Materials and Procedures: Conform to ASME Section IX and applicable provincial labour regulations.
- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.12 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, protect and handle products in accordance with Division 01 and Section 20 00 01 – Common Work Results – Mechanical.
- .2 Accept valves on site in shipping containers with labeling in place.
 - .1 Inspect for damage.
- .3 Provide temporary protective coating on cast iron and steel valves.
- .4 Provide temporary end caps and closures on piping and fittings.
 - .1 Maintain in place until installation.
- .5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.13 SYSTEM DEMONSTRATION AND TRAINING

- .1 General Requirements

- .1 Provide system demonstration and training for the work of this Section in accordance with the requirements of Section 20 00 01 – Common Work Results – Mechanical.
- .2 Specific Requirements
 - .1 In addition to the training requirements of Section 25 05 01 – EMCS General Requirements and Section 20 00 01 - Common Work Results – Mechanical, provide the following:
 - .1 Instruction on the use of grooving tools and installation of grooved joint products.

1.14 VALVE IDENTIFICATION

- .1 Include all valves of this section in the Valve Tag Directory required by Section 20 15 43 – Identification.

Part 2 Products

2.1 VALVES

- .1 In accordance with Section 20 20 09 – Valves – Hydronic Systems.

2.2 PIPE HANGERS AND SUPPORTS

- .1 In accordance with Section 20 15 29 – Bases, Hangers and Supports.

2.3 FABRICATION

- .1 Do work in accordance with ASME B31.1.
- .2 Joints:
 - .1 Accessible locations: screwed, flanged or welded to match piping specification.
 - .2 Elsewhere: welded throughout, except at flanged components.
 - .3 Grooved joints on applicable systems in lieu of welded, flanged, or screwed joints and components.
- .3 Screwed joints:
 - .1 To ANSI/ASME B1.20.1.
 - .2 Provide clean machine-cut threads.
 - .3 Use PTFE tape or lead-free pipe dope or paste on male threads.
- .4 Branch connections:
 - .1 Use butt or socket-weld fittings.
 - .2 Mains NPS 2-1/2 and smaller: use weldolets, threadolets, or 2 Mpa half couplings as reinforcements.
 - .3 Mains NPS 3 and larger: welded branch connections can be used.
 - .4 In grooved systems: tees and reducing tees can be used.

2.4 UNIONS, FLANGES, AND COUPLINGS

- .1 Unions for Pipe 50 mm and Under:
 - .1 Ferrous Piping: 1034 kPa malleable iron, threaded.
 - .2 Copper Pipe: Bronze, soldered joints.
- .2 Flanges for Pipe Over 50 mm
 - .1 Ferrous Piping: 1034 kPa forged steel: slip-on type; except at connections to butterfly valves use weld-neck type.
 - .2 Copper Piping: 1034 kPa bronze slip-on type.
 - .3 Gaskets: 1.6 mm thick preformed neoprene.
- .3 Studs, bolts and nuts:
 - .1 Studs, bolts: With heavy hex heads, alloy steel to ASTM A307, grade B.
 - .2 Nuts: Semi-finished heavy hex., to ASTM A563.
- .4 Dielectric Connections:
 - .1 Up to 50 mm: brass threaded to solder pipe adaptors.
 - .2 Over 50 mm: isolating flanges.

2.5 EQUIPMENT DRAINS AND OVERFLOWS

- .1 Steel Pipe: ASTM A53, Schedule 40 galvanized.
 - .1 Fittings: Galvanized cast iron, or ASTM B16.3 malleable iron.
 - .2 Joints: Threaded, or grooved mechanical couplings.
- .2 Copper Tubing: ASTM B88, Type M and DWV, M, L, hard drawn.
 - .1 Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - .2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220 to 280 degrees C.

2.6 HEATING WATER AND GLYCOL PIPING, ABOVE GROUND

- .1 Steel Pipe: ASTM A53 seamless, Schedule 40, 10 mm wall for sizes 300 mm and over, black.
 - .1 Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type fittings.
 - .2 Joints:
 - .1 Sizes up to 50 mm: threaded
 - .2 Sizes over 50 mm: welded
- .2 Copper Tubing: ASTM B88, Type L or K, hard drawn.
 - .1 Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 - .2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220 to 280 degrees C. Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 640 - 805 degrees C.

2.7 HEATING WATER AND GLYCOL PIPING, BURIED

- .1 System: pre-fabricated factory insulated piping system complete with kits for field installation of insulation and jacket on pipe fittings, rated for continuous fluid operating temperature of 940C.
- .2 Pipe: steel to ASTM A53 seamless, Schedule 40, 10 mm wall for sizes 300 mm and over, black.
- .3 Insulation and casing:
 - .1 Pipe: Rigid polyurethane foam, factory applied, min density of 38.4 kg/m³ to ASTM D 1622, 90% minimum closed cell content to ASTM D2856, maximum water absorption 4% by volume to ASTM D2842, Insulation covered with 50 mil thick U/V inhibited black polyethylene jacket.
 - .1 Thickness:
 - .1 Heating water and glycol: 75mm
 - .2 Chilled water: 50mm
 - .2 Fittings: Rigid polyisocyanurate foam insulation with a fully bonded polymer protective coating on exterior and interior surfaces, including ends. Kits to be supplied complete with silicone caulking for seams, stainless steel attachment straps and clips, and heat shrink sleeves or butyl mastic tape to seal between pipe and insulation kit.
 - .4 Surveillance System.
 - .1 Provide and install a surveillance system for detection of moisture in the insulation by means of two sensor wires embedded in insulation of pipes and components.
 - .2 Provide and install an electronic fault locator capable of indicating precisely where in the pipe network a fault has arisen. The system shall be able to monitor multiple pipes to suit proposed installation. The system shall be complete with LAN and/or GPRS modem relay outputs for transmission of measured values. Coordinate with EMCS contractor for compatibility to EMCS system prior to ordering. Unit shall be complete with XTool surveillance software and 120V to 12V transformer.
 - .3 Acceptable material: LOGSTOR RedDetect X4.
 - .5 Acceptable material: URECON Standard U.I.P Medium Temperature System

2.8 ANCHORS, GUIDES, SLIDES

- .1 Anchors:
 - .1 Provide as indicated.
- .2 Alignment guides:
 - .1 Provide as indicated.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers on chilled water mains: Jackets to remain uninterrupted.
- .3 Pipe slides:

- .1 For [lateral] [longitudinal] movement as indicated with carbon steel base with filled PTFE pad and 1 mm thick Type 304 stainless steel slide plate covering full face of saddle and tack-welding along sides of saddle.
- .2 Provide approved graphite silicone lubricant between metal-to-metal surfaces and bearings as recommended by manufacturer.

2.9 EXPANSION LOOPS

- .1 Expansion loops in accordance with stress limits set out in ANSI/ASME B31.1.
- .2 Provide as indicated, using distribution piping and fittings.

2.10 EXPANSION JOINTS - BALL TYPE

- .1 General:
 - .1 Permanently installed recharge cylinders, number of cylinders to manufacturer's recommendations.
 - .2 Cylinder lubricant injection: perform under full line pressure.
- .2 Construction:
 - .1 Carbon steel casing, retainer and ball.
 - .2 Retainer: bolted to permit correct seal ring adjustment and disassembly.
 - .3 Ball: protected with crack-free chrome plating.

2.11 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L of water in system.
- .2 Sodium Carbonate: 0.40 kg per 100 L of water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L of water in system.

Part 3 Execution

3.1 PREPARATION

- .1 Lay out work in accordance with lines and grades as indicated.
- .2 Verify lines, levels, dimensions as indicated against established benchmarks.
 - .1 Report discrepancies to the Consultant and obtain written instruction.
- .3 When required by the Consultant, provide drawings showing relative locations of various services.

3.2 WELDING

- .1 Perform welding in accordance with Section 23 05 17- Pipe Welding supplemented as specified herein.
- .2 Notwithstanding the requirements of referenced section, the following shall apply:
 - .1 Welding to be in accordance with ASME B31.1.
 - .2 Welding to be executed by certified pipe welders.

- .3 Pipe fitting to be executed by certified pipe fitters.

3.3 GROOVED JOINTS

- .1 Install grooved joints in accordance with manufacturer's latest published installation instructions.
- .2 Ensure grooved ends are clean, free from indentations, projections, and roll marks in the area from pipe end to groove.
- .3 Select gaskets with elastomer grade suitable for intended service and produced by the coupling manufacturer.

3.4 INSTALLATION

- .1 General:
 - .1 Installation to be performed by certified pipe fitters.
 - .2 Install to manufacturer's instructions.
 - .3 Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9.
 - .4 Route piping in orderly manner, parallel to building structure, and maintain gradient.
 - .5 Install piping to conserve building space, and not interfere with use of space.
 - .6 Group piping whenever practical at common elevations.
 - .7 Sleeve pipe passing through partitions, walls and floors.
 - .8 Slope piping and arrange to drain at low points.
 - .9 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 15125.
 - .10 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15081.
 - .11 Provide access where valves and fittings are not exposed. Provide access doors to Section 15010 to access through non-accessible ceilings and walls.
 - .12 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
 - .13 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
 - .14 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 9.
 - .15 Embed only polyethylene or composite polyethylene piping in concrete slab in radiant slab heating piping systems.
- .2 Install pipework in accordance with Section 23 05 05- Installation of Pipework supplemented as specified herein.
- .3 Clearances:

- .1 Maintain clearance around systems, equipment and components and between pipes and structures for O&M as indicated, as directed and to manufacturer's recommendations, for greater of:
 - .1 Observation of operation, inspection, servicing, maintenance.
 - .2 Disassembly, removal of equipment and components without interrupting operation of other system, equipment, components.
- .2 Except where indicated, install to permit separate thermal insulation of pipes.
- .4 Provide drip legs, dirt pockets at low points.
- .5 Flanges:
 - .1 Use suitable graphite lubricant on bolts and nuts.
 - .2 Tighten bolts evenly with torque wrench.
- .6 Manual Air Vents:
 - .1 Install at high points in piping systems and elsewhere as indicated.
 - .2 To consist of full-size tee, pipe extension and accumulator, cap and shut off valve, discharge pipe to floor drains with visible termination.
- .7 Butterfly Valves:
 - .1 Install between weld-neck flanges.
- .8 Drain Valves:
 - .1 Install at low points in piping systems, at equipment, at section isolating valves and elsewhere as required.
 - .2 Pipe drain valves discharge separately to above floor drain.
 - .1 Discharge to be visible.
 - .3 Weld couplings for drains into piping to ASME B31.1.
- .9 Seal piping passing through walls with approved firestopping compatible with surface temperature of pipe or insulation.
- .10 Provide for pipe movement as indicated.
- .11 Branch Take-Offs:
 - .1 Use welding tees.
 - .2 Where reducing tees of proper size are unavailable, use available tees with reducers.
 - .1 Tees with increasers not acceptable.
 - .3 Weldolets may be used at drip legs only provided ratio of outlet size to pipe size is 0.5 or smaller.
- .12 Cap open ends of piping during installation.
 - .1 Remove foreign material from inside piping.
- .13 Grade nominally horizontal piping to high point for air removal and low point for condensate drainage.

- .14 Revisions to location of piping require written approval of [Consultant] [DCC Representative] [Departmental Representative].
- .15 Connections to Equipment:
 - .1 Use flanged valves for isolation and ease of maintenance and assembly.
 - .2 Use double swing joints and swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .16 Expansion Joints:
 - .1 Install to manufacturer's recommendations.
 - .2 Install lubrication facilities in locations for ease of servicing.
- .17 Anchors and Guides:
 - .1 Locate anchors and guides as indicated and in accordance with manufacturer's recommendations.
 - .2 Align piping at expansion loops and guides to avoid damage by movement of piping against fixed structures.

3.5 COLD SPRINGING

- .1 Except where cold springing is indicated or specified, do not force pipes into position.
- .2 Cold springing and pre-compression requirements to be based upon ambient temperature during installation of 20°C
- .3 Cold springing of expansion loops, offsets: as indicated and in presence of Departmental Representative
- .4 Cold springing of expansion joints: to recommendation of manufacturer and in presence of Departmental Representative.
- .5 Pre-compress expansion joints in accordance with manufacturer's recommendations.

3.6 PIPE SUPPORTS

- .1 In accordance with Section 20 20 05- Installation of Pipework supplemented as specified herein.
- .2 Install to manufacturer's recommendations.
- .3 Expansion loops and expansion joints:
 - .1 Provide supports as indicated, to manufacturer's recommendations as required to maintain drainage.

3.7 STRAINERS

- .1 Install in locations to allow easy access for removal of screen.

3.8 THERMOWELLS

- .1 In general, to be installed in elbows.
 - .1 Minimize turbulence and resistance to flow.

- .2 Install in direction of flow.
- .3 Full length of thermowell to be in the fluid being measured.
- .4 Increase size of piping to ensure velocity of fluid at thermowell is equal to flow rate in adjacent piping.

3.9 EXAMINATION AND INSPECTIONS

- .1 Leave joints in piping systems uncovered until tests are completed and system inspected and approved by Consultant.
- .2 Radiographic examinations:
 - .1 Notwithstanding inspection specified in Section 23 05 17 - Welding, carry out radiograph examinations of 10% of welds on HP steam, HP condensate and HP drip to ANSI/ASME B31.1M.
 - .2 If joints on a 10% radiographic test fail, radiograph all joints performed by welder whose joint failed.
 - .3 Radiograph repaired joints to ANSI/ASME B31.1M.
 - .4 Perform magnetic particle tests on welded slip-on flanges.
 - .5 Submit results of radiographs, together with copy of welder's licence and description of procedures used.
- .3 Contractor to examine new piping prior to hydrostatic pressure tests for compliance with approved drawings and specifications.
- .4 Pay costs for examinations.

3.10 HYDRONIC PIPE FLUSHING AND CLEANING

- .1 Conditions of Procedure:
 - .1 Systems to be operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
 - .2 Systems to be free from construction debris, dirt and other foreign material.
 - .3 Control valves to be operational, fully open to ensure that terminal units can be cleaned properly.
 - .4 Strainers to be clean prior to initial fill.
 - .5 Install temporary filters on pumps not equipped with permanent filters.
 - .6 Install pressure gauges on strainers to detect plugging.
- .2 Cleaning Agency:
 - .1 Retain services of qualified water treatment specialist to perform system cleaning.
- .3 Hydronic Systems Procedure:
 - .1 If using temporary connection into potable service, ensure that there is no possibility of backflow or cross-contamination.
 - .2 Fill system with water or correct heat transfer fluid, ensure air is vented from system.

- .3 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
- .4 Use water metre to record volume of water in system to +/- 0.5%
- .5 Add chemicals under direct supervision of chemical treatment supplier.
- .6 Closed Loop Systems:
 - .1 Circulate system cleaner at 60 degrees C for at least 36 hours.
 - .2 Drain as quickly as possible.
 - .3 Refill with water and inhibitors.
 - .4 Test Concentrations and adjust to recommended levels.
- .7 Flush velocity in system mains and branches to be adequate to ensure removal of debris.
 - .1 System pumps may be used for circulating cleaning solution provided velocities are adequate.
- .8 Add cleaning solution to system.
- .9 Establish circulation, raise temperature slowly to 82 degrees minimum.
 - .1 Circulate for 12 hours ensuring flow in circuits.
 - .2 Remove heat, continue to circulate until temperature is below 38 degrees C.
 - .3 Drain quickly as possible.
 - .4 Refill with clean water.
 - .5 Circulate for 6 hours at design temperature.
 - .6 Drain.
 - .7 Repeat procedures specified above.
 - .8 Flush through at low point drains in system.
 - .9 Refill with clean water adding sodium sulphite (test for residual sulphite).
- .10 Install instrumentation including flow meters, orifice plates, Pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Glycol Systems Procedure:
 - .1 In addition to procedures specified for Hydronic Systems perform the following.
 - .1 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.11 HYDRONIC PIPE PRESSURE TESTING

- .1 General
 - .1 Provide equipment, materials, testing media and labour for pressure testing and pay all expenses.
 - .2 Use pressure test instruments meeting requirements specified herein.
 - .3 Provide approved chart recorder to record piping pressure tests.

- .4 Test apparatus to be accurate to within +/- 3 % of flow rate and pressure.
- .5 Submit details of test instruments as a shop drawing.
- .6 Instruments to be re-calibrated every six months thereafter.
- .2 Timing
 - .1 Perform testing after installation but before concealing.
- .3 Procedure
 - .1 Verify that:
 - .1 All valves are acceptable.
 - .2 Instrument tappings are accessible, and adequate clearance has been provided to attach instruments.
 - .3 Major pieces of equipment are serviceable and connected to system with flanges or unions, etc.
 - .4 All pipe expansion has been allowed for.
 - .2 Isolate equipment and other parts which are not designed to withstand test pressure or test media.
 - .3 Subject piping to hydrostatic pressure tests to 1.5 times maximum working pressure, or 860 kPa (whichever is greater), and maintain test pressure without loss for 24 hours.
 - .1 Carry out pressure test for an 8-hour period and maintain pressure with no appreciable pressure drop.
 - .1 Where leakage occurs, repair and restart test
 - .2 Record all tests with approved chart recorder.
 - .4 Provide additional supports to steam piping as required and remove after testing is successfully completed.
 - .5 Conduct tests in presence of Consultant (when requested) and as required by the authority having jurisdiction.
 - .6 Insulate or conceal work only after acceptance by Consultant and authority having jurisdiction.
 - .7 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct defects.
 - .1 Correct leaks by remaking joints in screwed fittings, cutting out and re-welding welded joints, remake joints in copper lines. Do not caulk.
- .4 Acceptance Criteria
 - .1 Bear costs for tests, for repairs or replacement, retesting, making good.
 - .2 The submittal shall be considered complete upon the Consultant's written acceptance of the documentation.

3.12 HYDRONIC SYSTEM START-UP

- .1 Timing:
 - .1 Start up hydronic system after:
 - .1 Cleaning is completed.

- .2 Pressure tests are completed.
 - .3 Joints radiographed as specified.
 - .4 Water treatment system has been commissioned.
 - .5 Painting of supports, steelwork to be completed before heat is applied to system.
- .2 Provide continuous supervision during start-up.
 - .3 Start-up Procedure:
 - .1 Perform start-up after cleaning is complete and systems are filled
 - .2 Establish circulation and expansion tank level, set pressure controls
 - .3 Ensure air is removed.
 - .4 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .5 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .6 Clean out strainers repeatedly until system is clean.
 - .7 Commission water treatment system as specified in Section 23 25 00 – HVAC Water Treatment Systems.
 - .8 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON. Repeat with water at design temperature.
 - .9 Repeat with water at design temperature
 - .10 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation.
 - .11 Bring system up to design temperature and pressure slowly over a 48-hour period.
 - .12 Eliminate water hammer and other noises.
 - .13 Perform TAB as specified in Section 20 30 01- Testing, Adjusting and Balancing.
 - .14 Adjust pipe supports, hangers, springs as necessary.
 - .15 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .16 During warm-up, check operation of expansion loops, joints, anchors and guides.
 - .17 If sliding type bind, or if bellows type flex incorrectly, shut down system, re-align, repeat start-up sequence.
 - .18 Verify adequacy of accessibility to expansion joints for servicing.
 - .19 Re-tighten bolts, using torque wrench, to compensate for heat-caused relaxation.
 - .1 Repeat several times during commissioning.
 - .20 Check operation of drain valves.
 - .21 Adjust valve stem packings as systems settle down.
 - .22 Fully open balancing valves (except those that are factory-set).
 - .23 Check operation of over-temperature protection devices on circulating pumps.

- .24 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.
- .25 Check pressure bypass operation (if provided).
- .26 Test operation of operating, limit and safety controls.
- .27 Verify performance and thermal efficiency at various flow rates produced during these tests.
- .28 Check operation of make-up system by simulating blowdown and leakage.
Adjust PRV on water make-up.
 - .1 Ensure backflow preventer is operating properly.
- .29 Record pressure drops across control valves at design flow rate.
- .30 Check for water hammer or water noise.
 - .1 Fasten loose items of equipment to ensure quiet operation of system.

3.13 PERFORMANCE VERIFICATION

- .1 Timing:
 - .1 Perform performance verification only after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
 - .5 Pressure tests successfully completed.
 - .6 Flushing as specified has been completed.
 - .7 Water treatment system has been commissioned.
- .2 Procedure:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Boiler and/or chiller operation.
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Boiler and/or chiller failure.
 - .7 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.
 - .3 Heating System Capacity Test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions.

- .2 Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
- .3 Test procedures:
 - .1 Open fully heat exchanger, heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
 - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.
- .4 Glycol System Capacity Test:
 - .1 Perform capacity test to prove concentration will prevent freezing to minus 40degrees C Test inhibitor strength and include in procedural report.
 - .2 Refer to ASTM E202.
- .5 Verification requirements in accordance with Section 01 47 17- Sustainable Requirements: Contractor's Verification include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Certified wood.
 - .8 Low-emitting materials.

3.14 COMMISSIONING

- .1 Instrumentation:
 - .1 Verify accuracy of thermometers and pressure gauges by comparison with calibrated test instruments.
- .2 Full Scale Tests:
 - .1 Upon completion, conduct full scale tests at maximum design flow rates, operating temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design requirements.
- .3 If steam system is designed to go off-line frequently, (producing excessive quantities of condensate) verify adequacy of condensate removal systems.
- .4 Reports:

- .1 In accordance with Section 01 91 13- General Commissioning (Cx) Requirements:
 - .1 Reports:
 - .1 supplemented as specified herein.
- .5 Training:
 - .1 In accordance with Section 01 91 13- General Commissioning (Cx) Requirements]: Training of O&M Personnel, supplemented as specified herein.

3.15 IDENTIFICATION

- .1 In accordance with Section 20 15 43 – Identification supplemented as specified herein.

END OF SECTION