

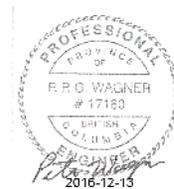
# HVAC UPGRADES SPECIFICATIONS



**DFO Cultus Lake Laboratory**  
December 1, 2016

V 3.0 Issue for Tender

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**END OF SECTION**

**Part 1 General**

**1.1 WORK COVERED BY CONTRACT DOCUMENTS**

ØÁ Y qtn'qh'yj ku'Eqpvtcev'eqo r tkgu'tgr rægo gpv'qh'y q'ckt'eqpf kkkpki 'wpku.'yj g'cf f kkkp'qh' cp'gzj cwu'hcp'cpf 'tgrgh'qr gplki 'r mw'wr i tcf gu'vq'yj g'o gej cplecni'u{uogo u'cpf 'eqpvtqni' u{uogo u'lp'yj g'F gr ctvo gpv'qh'Hkuj gtlgu'cpf "Qegcpu'Ecpfc c.'Ncdqtcvqt {"dwwf kpi 'hjecv'gf " kp'E wmwu'Ncng. "DE0'

ØÁ Vj g'Ueqr g'qh'Y qtn'kpenw'f gu'yj g'hqmjy kpi 'kgo u<

- Á Tgo qxg'y q.'gzkukpi 'ur rk'u{uogo 'ckt'eqpf kkkpki 'wpku."DE W/3"cpf "4="
- Á Tgo qxg'tge{erg'"cm'tghki gtcpv'htqo 'gs wkr o gpv'dghgt'g'tgo qxkpi 'gs wkr o gpv="
- Á Rtqxf g'pgy 'ur rk'u{uogo 'j gcv'r wo r u="J R3"cpf "J R4"kp'qqt'cpf "qwf qqt'wpku="
- Á O qf kh'f wew qtn'cu'lp'f lecv'gf 'lp'yj g'f tcy kpi u="
- Á Tgqecv'gzkukpi 'hwxg'cpf 'tqxkf g'pgy 'lp'v'ng'hwxg'cu'lp'f lecv'gf 'qp'yj g'f tcy kpi u0"
- Á Rtqxf g'pgy "gzj cwu'hcp."GH/323="
- Á Rtqxf g'r gpgtcv'kpu.'qr gplki 'htco gy qtm'hruj kpi 'cpf 'ugcrkpi 'y qtn'vq'r tgr ctg'cpf " o cng'i qaf "cp{"r gpgtcv'kpu'wcej o gpw'lp'kp'gz'vgt'kq'ty cmu="
- Á Rtqxf g'pgy 'vgo r gtcwtg'ugpuqtu.'yj gto qucwu.'f co r gtu.'cewcv'qtu'cpf 'eqpvtqngtu'cu'" " lp'f lecv'gf 'lp'yj g'f tcy kpi u="
- Á Rtqxf g'c'pgy 'f ki kcn'eqpvtqni'u{uogo . 'cu'ur gek'kgf . 'v'eqpvtqni'yj g'pgy "cpf "gzkukpi '" " J XCE 'Gs wkr o gpv'cu'lp'f lecv'gf ="
- Á Rtqxf g'eqpvtqni'ht'gzkukpi "dqkgt.'r tko ct {"'ugeqpf ct {"'cpf 'tgj gcv'eqk'f'ekt'ewr'v'kq'" " r wo r u.'eqpvtqni'xcrgu'cpf "qr gtcv'kpcni'ucwu'qh'yj g'yj tgg'gzkukpi 'hwo g'j qaf u="
- Á Rtqxf g'j qv'y cvg'eqpvtqni'xcrgu'cpf 'tqqo 'vgo r gtcwtg'ugpuqtu'" " y j g'g'lp'f lecv'gf "qp'yj g'f tcy kpi u="
- Á Eqpf wev'cp'ckt'dc'p'eg'qh'yj g'ckt'j cpf rki 'u{uogo u="
- Á Eqpf wev'ergcpki 'cpf 'v'gukpi 'qh'pgy 'r kr kpi 'u{uogo u="
- Á Eqpf wev'ergcpki 'qh'pgy 'cpf 'gzkukpi 'f wew qtm="
- Á Rtqxf g'Grgevt'lecn'y qtn'cu'q'lecv'gf 'y kj 'yj g'wr i tcf g'qh'yj g'o gej cplecni'u{uogo u="
- Á Eqo o kukap'cm'gs wkr o gpv'cpf 'r tqxf g'eqo o kukapki 'tgr qt'u'ht'cm'gs wkr o gpv'" " cpf 'u{uogo u'w'r r r'kgf 'wp'gt'yj ku'eqpvtcev="
- Á Rtqxf g'Qr gtcv'kpi 'cpf 'O c'k'p'g'p'eg'O cpwcu'cpf 'Cu/Dwku'F tcy kpi u="cpf "
- Á Rtqxf g'qp'ukg'v'cl'kpi 'ht'yj g'Qr gtcv'kpu'v'ch'0'
- Á Rtqxf g'3'{"gct'r ctu'cpf 'h'edqwt'y cttcp'v'0'

ØÁ Vj g'Uej gf w'g'qh'Y qtn'lj cni'eqo r n' 'y kj 'yj g'hqmjy kpi 'uej gf w'g<

- Á Eqpvt'w'v'kq'p'y qtn'lj cni'dg'w'du'v'k'cm'f 'eqo r r'gv'gd {"O c {"53."42390'
- Á Cni'eqpvt'w'v'kq'p'cpf "f g'he'k'p'e {"hqmjy /w' 'y qtn'lj cni'dg'eqo r r'gv'gf "L'wp'g'52."4239"



**1.6 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING**

ØÁ Gzgewg'y qtn'y kj 'rgcu'r quukdr'kpvghgtgpeg"qt"fkwwdcepeg"vq"dwkf kpi "qr gtcvkqpu'cpf "  
pqto cn'wug'qh'r tgo kugu0Cttcpi g'y kj 'Eqpuwncpv'vq'hcekkvcg'gzgewkqp'qh'y qtn0

**1.7 DOCUMENTS REQUIRED**

ØÁ O ckpvckp"cv'lqd'ukg."qpg'eqr {"gcej "F qewo gpv'cu'hqmqy u<

ØÁ Eqpvcevf'F tcy kpi u0

ØÁ Ur gekhcevkqpu0

ØÁ Cffgpf c0

ØÁ Tgxky gf "Uj qr "F tcy kpi u0

ØÁ Nkuv'qh'Uwdo kwgf "cpf "Qwucpf kpi "Uj qr "F tcy kpi u0

ØÁ Ej cpi g'Qtfgtu0

ØÁ Qj gt "O qf khcevkqpu'vq'Eqpvcevf0

ØÁ Hkgr "Vguv'Tgr qt u0

ØÁ Eqr {"qh'Cr r tqxgf "Y qtm'Uej gf wrg0

Ø2Á J gcnj "cpf "Uchgv{"Rrcp"cpf "Qj gt "Uchgv{"Tgrvgr "F qewo gp u0

**Part 2 Products**

**2.1 NOT USED**

ØÁ Pqv'wugf 0

**Part 3 Execution**

**3.1 NOT USED**

ØÁ Pqv'wugf 0

**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 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 Consultant 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        Consultant will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.
- .5        Use only elevators and hallways existing in building for moving workers and material.
  - .1        Accept liability for damage, safety of equipment and overloading of existing equipment.
- .6        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 building operations and normal use of premises. Arrange with Consultant to facilitate execution of work.

**1.4                SPECIAL REQUIREMENTS**

- .1        Carry out noise generating or dust generating Work and work in occupied areas, Monday to Friday from 18:00 to 07:00 hours and on Saturdays, Sundays and statutory holidays.
- .2        Provide temporary heating and ventilation systems for HVAC services that are interrupted during normal working hours. Work after hours if necessary to avoid interruptions to electrical and HVAC services during the facility's normal operating hours.
- .3        Submit schedule for installation of Work.
- .4        Ensure that Contractor personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .5        Keep within limits of work and avenues of ingress and egress.
- .6        Ingress and egress of Contractor vehicles at site is limited to delivery of Material and removal of redundant equipment.

**1.5 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 the premises, unless directed otherwise by the owners representative.
- .2 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.

**1.6 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 Consultant at least 10 days before service is needed. For requests submitted within time noted above, costs of security escort will be paid for by a DFO 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 4 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 eight hours per day for late service request and of four hours for late cancellations.

**1.7 BUILDING SMOKING ENVIRONMENT**

- .1 Comply with smoking restrictions. Smoking is not allowed on site

**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            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 Consultant 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 SUBMITTALS**

- .1 Provide submittals in accordance with Section 21 05 01 – Mechanical General Requirements.
- .2 Submit to Consultant within 5 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 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 Submit equipment shop drawings for review within 10 working days of the Award of Contract.
  - .2 Mechanical and electrical work completed within 67 calendar days of Award of Contract date.
  - .3 Interim Certificate (Substantial Completion) within 72 calendar days 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 Consultant will review and return revised schedules within 5 working days.
- .3 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 of Contract.
- .2 Shop Drawings, Samples.
- .3 Permits.
- .4 Mobilization.
- .5 Mechanical
- .6 Electrical.
- .7 Controls.
- .8 Testing and Commissioning.
- .9 Substantial Completion.

**1.7 PROJECT SCHEDULE REPORTING**

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

**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                RELATED REQUIREMENTS**

- .1        Section 01 77 00 – Closeout Submittals.

**1.2                ADMINISTRATIVE**

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

**1.3                SHOP DRAWINGS AND PRODUCT DATA**

- .1        The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2        Submit drawings stamped and signed by professional engineer registered or licensed in British Columbia, Canada.
- .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 7 business days for Consultant's review of each submission.
- .5 Adjustments made on shop drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .6 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant 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 Consultant's review, distribute copies.

- .10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Consultant may reasonably request.
- .11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Consultant 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 Consultant.
  - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
  - .2 Testing must have been within 3 years of date of contract award for project.
- .13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Consultant.
  - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
  - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Consultant.
  - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Consultant.
- .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 Consultant.
- .18 Delete information not applicable to project.
- .19 Supplement standard information to provide details applicable to project.
- .20 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .21 The review of shop drawings by Prism Engineering is for sole purpose of ascertaining conformance with general concept.
  - .1 This review shall not mean that Prism Engineering 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.
- .22 Each shop drawing shall be **checked** and **stamped** as being correct, by trade purchasing item, and by the Contractor, before drawing is submitted to Consultant for review. If above requirements are not complied with, shop drawings will be rejected and returned forthwith.
- .23 Do not have equipment delivered to site until a shop drawing for the item has been reviewed, stamped as accepted or modified by Consultant and returned to Contractor.

#### **1.4 EQUIVALENCY**

- .1 Manufacturer products listed in these specifications are provided as materials or equipment already reviewed and accepted for inclusion in the Work. These listed materials or equipment demonstrate the minimum quality and performance of materials and equipment that manufacturers offerings and requests for equivalency must demonstrate in order to be considered for inclusion in the project.
- .2 Unless stated 'no equivalent', manufacturers, their agents or representatives may and are invited to submit materials or equipment for consideration as equivalent to listed materials or equipment by submitting written request to the Consultant and providing information for submittals as detailed within these specifications.
- .3 All requests for equivalency must be submitted no later than three days prior to the close of tender or request for pricing.

#### **1.5 DETAIL DRAWINGS AND INSTRUCTIONS**

- .1 Submit notification of locations where installation of piping, fittings and equipment would interfere with interior treatment and use of building. Detail drawings or instructions exactly locating these items will then be issued.
- .2 Submit all the drawings respecting the work to the Consultant, upon request, for acceptance before using them. Contractor is responsible for performing the work properly notwithstanding such acceptance.
- .3 Perform the work in accordance with drawings and instructions supplied by the Consultant but do not use such drawings for construction, manufacture or installation unless the Consultant has released them for such use.
- .4 Inform the Consultant of any instructions given by any parties that would affect the equipment, quantities, locations, price, or any modification to the work as outlined in this Contract. Failure to comply may result in the rejection of the work or any associated costs.

**1.6 PHOTOGRAPHIC DOCUMENTATION**

- .1 Submit electronic copy of colour digital photography in fine resolution as directed by Consultant.
  - .1 Upon completion of: installation of new heat pumps and other HVAC upgrades.

**1.7 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        SECTION INCLUDES**

- .1        Health and safety considerations required to ensure that DFO shows due diligence towards health and safety on construction sites, and meets the requirements laid out in PWGSC/RPB Departmental Policy DP 073 - Occupational Health and Safety - Construction.

**1.2        REFERENCES**

- .1        Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2        Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1        Material Safety Data Sheets (MSDS).
- .3        Province of British Columbia
  - .1        Workers Compensation Act, RSBC 1996 - Updated 2006.

**1.3        SUBMITTALS**

- .1        Make submittals in accordance with Section 21 05 01 – Mechanical General Requirements
- .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 Consultant.
- .4        Submit copies of reports or directions issued by Provincial health and safety inspectors.
- .5        Submit copies of incident and accident reports.
- .6        Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 21 05 01 – Mechanical General Requirements.
- .7        Consultant will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 5 days after receipt of plan. Revise plan as appropriate and resubmit plan to Consultant within 5 days after receipt of comments from Consultant.
- .8        Consultant's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

- .9 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

#### **1.4 FILING OF NOTICE**

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.

#### **1.5 SAFETY ASSESSMENT**

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

#### **1.6 MEETINGS**

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

#### **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.

#### **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 Workers Compensation Act, B.C.

#### **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 Consultant verbally and in writing.

#### **1.11 HEALTH AND SAFETY CO-ORDINATOR**

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:
  - .1 Have site-related working experience specific to activities associated with propane gas and refrigeration equipment installations.

- .2 Have working knowledge of occupational safety and health regulations.
- .3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
- .4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.
- .5 Be on site during execution of Work and report directly to and be under direction of site supervisor.

**1.12 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 Consultant.

**1.13 CORRECTION OF NON-COMPLIANCE**

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Consultant.
- .2 Provide Consultant with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Consultant may stop Work if non-compliance of health and safety regulations is not corrected.

**1.14 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                SECTION INCLUDES**

- .1            Text, schedules and procedures for systematic Waste Management Program for demolition, and renovation projects, including:
  - .1            Materials Source Separation Program (MSSP).
  - .2            Canadian Governmental Responsibility for the Environment Resources - Schedule E.

**1.2                DEFINITIONS**

- .1            Demolition Waste Audit (DWA): Relates to actual waste generated from project.
- .2            Recyclable: Ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse by others.
- .3            Source Separation: Acts of keeping different types of waste materials separate beginning from first time they became waste.

**1.3                STORAGE, HANDLING AND PROTECTION**

- .1            Unless specified otherwise, materials for removal become Contractor's property.
- .2            All work on equipment containing halocarbons must be done by a certified Refrigeration Technician. All decommissioning and installation of equipment containing halocarbons shall be done in compliance with the Federal Halocarbon Regulations.
- .3            Protect, stockpile, store and catalogue salvaged items.
- .4            Applies to the existing heat pumps and equipment which is replaced/upgraded with new equipment.

**1.4                DISPOSAL OF WASTES**

- .1            Keep records of construction waste.
- .2            Remove materials from site as work progresses.
- .3            Prepare project summary to verify destination and quantities on a material disposed.
- .4            Documentation/receipts verifying proper disposal/handling of hazardous materials shall be submitted to the Consultant and inserted into the Operating and Maintenance manuals.

**1.5                SCHEDULING**

- .1            Coordinate Work with other activities at site to ensure timely and orderly progress of Work.

**Part 2          Products**

**2.1              NOT USED**

- .1          Not Used.

**Part 3          Execution**

**3.1              APPLICATION**

- .1          Do Work in compliance with DWA.
- .2          Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.
- .3          All halocarbon materials shall be removed from equipment and recycled.

**3.2              CLEANING**

- .1          Remove tools and waste materials on completion of Work, and leave work area in clean and orderly condition.
- .2          Clean-up work area as work progresses.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

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

**1.2                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 Consultant in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
    - .2            Request Consultant's inspection.
  - .2            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, balanced and fully operational.
    - .4            Certificates required.
    - .5            Record drawing in CAD and PDF format prepared from the marked up record drawing on site.
    - .6            Preparation of Electrical and Mechanical Maintenance Manuals
    - .7            Work: complete and ready for final inspection.
    - .8            Operation of systems: demonstrated to Owner's personnel.  
Commissioning of mechanical systems: completed in accordance with 01 91 13 - General Commissioning (Cx) Requirements and and copies of final Commissioning Report submitted to Consultant.
  - .3            Final Inspection:
    - .1            When completion tasks are done, request final inspection of Work by Consultant.
    - .2            When Work incomplete according to Consultant, complete outstanding items and request re-inspection.

**1.3                FINAL CLEANING**

- .1            Clean and remove surplus materials, excess materials, rubbish, tools and equipment.
- .2            Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition 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                ADMINISTRATIVE REQUIREMENTS**

- .1        Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of substantial performance.
- .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.
  - .4        Ensure testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning (Cx) 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 scheduled times, at the equipment 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.
- .5        Time Allocated for Instructions: ensure amount of on-site time required for instruction of each item of equipment or system as follows:
  - .1        Sections 23 0000 –Heat Pump Upgrades: 2 hours of instruction
  - .2        Section 25 05 01 - Control Systems: 3 hours of instruction.
  - .3        Section 26 05 21 - Electrical System: 1 hour of instruction.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 21 05 01 – Mechanical General Requirements.
- .2        Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Owner's and Consultant'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                SECTION INCLUDES.**

- .1            Commissioning, testing and documentation of the installation of all upgraded/replaced equipment and HVAC components.

**1.2                DEFINITIONS**

- .1            Commissioning: The process for achieving, verifying, and documenting that the new equipment is installed, operating and tested to ensure that the Upgrade meets the original project requirements established by the Owner.
- .2            Commissioning Team:
  - .1            Owner's Representative: Project Manager, as defined in the Agreement.
  - .2            Consultant: as defined in the Agreement. The Consultant shall confirm the commissioning process has been completed by the Commissioning Manager and Commissioning Agent.
  - .3            Commissioning Manager and Commissioning Agent: Sub contractor(s) engaged by the mechanical contractor to lead and complete commissioning activities, and coordinate other team members.
  - .4            Contractor Representatives: Representatives of the Contractor, including any sub-contractors whose scope of work includes items requiring commissioning.
  - .5            Testing Agency: Specialty agency engaged by the contractor to perform tests on components or systems to verify conformance to the specified requirements.
- .3            Commissioning Documents to be provided by the Contractor:
  - .1            Commissioning Plan: A project-specific document which defines the scope and approach to commissioning of the new boiler plant.
  - .2            Submittal: Contract submittal, as specified in Contract Documents.
  - .3            Static check certificate: A document used to verify equipment data actually installed, prior to start-up or operation.
  - .4            Operating check certificate. A document used to verify equipment operation, including performance statistics.
  - .5            Startup Reports: Report prepared by equipment start-up personnel, including start-up sequence, and performance statistics.
  - .6            Balancing Report: Report prepared by the balancing agency, indicating initial and final system performance.
  - .7            Maintenance Manual: A document containing detailed descriptions and technical information about start-up, operation and maintenance of equipment.
  - .8            Commissioning Report: A document prepared by the Commissioning manager and submitted to the Consultant and containing list of checks conducted that ensure the new boiler plant is performing as designed.

### **1.3 METHODOLOGY**

- .1 The Commissioning Manager shall develop a Commissioning Plan, including as a minimum, the management of commissioning meetings, and the management of project-specific commissioning documents.
- .2 Commissioning shall conform to CSA Z320, Building Commissioning and PWGSC Commissioning Policy
- .3 CSA Standard Z320 shall be used for the basis of the commissioning process.
- .4 Commissioning Plan to include:
  - .1 Development of static and operating check certificates for individual equipment.
  - .2 Assembly of commissioning reports, including testing and balancing reports, maintenance manuals, start-up reports, and testing reports.
  - .3 Verification of data by testing agency.
  - .4 Audit procedure, to be performed in the event of dispute or failure.
- .5 Execute the commissioning plan.

### **1.4 REGULATORY REQUIREMENTS**

- .1 Arrange for regulatory authorities to witness those commissioning start up procedures which are also required by regulatory authorities.
- .2 Obtain certificates of approval and for compliance with regulations from Authorities Having Jurisdiction; include copies of certificates with start up reports.

### **1.5 CONTRACT COMMISSIONING REQUIREMENTS**

- .1 Witnessing: Allow commissioning team members the opportunity to witness starting, testing, adjusting, and balancing procedures. Provide advance notice of commissioning activities to the commissioning team members.
- .2 Allow Commissioning Manager and Auditor free access to the site.
- .3 Costs: Pay costs associated with starting, testing, adjusting, and relevant instruments and supplies required to perform those duties.
- .4 Employ experienced personnel for equipment startup and commissioning, who are able to interpret results of readings and tests, and report the system status in a clear and concise manner.
- .5 Provide all equipment required to perform testing, balancing, and commissioning of systems. Calibrate instruments used in start up as accurate; provide calibration certificates if requested by the Commissioning Manager.
- .6 Utilize equipment check certificates and other commissioning documents required by the Commissioning Manager.
- .7 Verify that equipment is installed in accordance with Contract Documents, and reviewed shop drawings. Sign and date static check certificates.
- .8 Do not start up equipment unless static check sheets have been completed and submitted.

- .9 Complete in detail, and sign operating check certificates.

**Part 2 Products**

**2.1 NOT USED**

**Part 3 Execution**

**3.1 COMMISSION TESTING**

- .1 Allow for work, effort, and associated costs necessary to assist the Commissioning Manager, for fulfilment of a commission testing process of the facility and Work.
- .2 Coordinate, cooperate, and harmonize efforts with the Commissioning Manager.
- .3 Commission testing will include commissioning services for all three boilers.
- .4 System and device checks to be suitably logged, tabulated, signed, and incorporated into project Operating and Maintenance Manuals:
  - .1 Coordinate site visits by the Commission Manager and the affected parties during warranty periods.
- .5 The commissioning process will not:
  - .1 Preclude the duties and responsibilities described in the Contract Documents nor the requirements and obligations of the Contract.
  - .2 Circumvent any required warranties.
  - .3 Relieve the Contractor from warranty requirements, responsibilities, or obligations.
- .6 Prior to commission testing, perform the following and provide copies to the Commissioning Manager, of component and assembly Contract Document compliance:
  - .1 Static test certificates.
  - .2 Equipment operating certificates.
  - .3 Three (3) copies of valve tag list.
  - .4 Inspection certificates from authorities having jurisdiction.
  - .5 Required copies of shop drawings.
  - .6 Manufacturer's operating and maintenance brochures of all major equipment.
- .7 Ensure all systems have been started, adjusted to design criteria, and are functionally operational, ready for independent testing.
- .8 Cooperate with the Commissioning Manager in advance of activating operating systems.
- .9 Test results that illustrate failure to conform to the Contract Documents, will result in the Owner arranging and paying to correct the Work at the Owner's discretion, and recovering all associated costs from the Contractor.

**3.2 AUDIT TESTING AND THE COMMISSIONING AUDITOR**

- .1 In the event on non-compliance or test failure described in the commission testing process above, comply with the following requirements.
- .2 Allow for work, effort, and associated costs necessary to assist an Owner appointed and remunerated Auditor, for fulfilment of a further audit testing of the facility and Work.
- .3 Coordinate, cooperate, and harmonize efforts with the Auditor.
- .4 Audit testing will include further random testing and evaluation as determined by the Owner, the Auditor, and the Commissioning Manager.
- .5 Suitably log, tabulate, and incorporate signed system and device check certificates into Operating and Maintenance Manuals.
- .6 Coordinate site visits by the Auditor, Commission Manager and the affected parties during warranty periods.
- .7 The audit process will not:
  - .1 Preclude the duties and responsibilities described in the Contract nor the requirements and obligations of the Contract.
  - .2 Circumvent any required warranties.
  - .3 Relieve the Contractor from warranty requirements, responsibilities, or obligations.
- .8 Cooperate with the Auditor prior to testing of operating systems.
- .9 Test results that demonstrate failure to conform to the Contract Documents, may result in the following, at the Owner's sole discretion:
  - .1 Complete rejection of the subject component, assembly, or system.
  - .2 Removal of defective items from the Work.
  - .3 An adjustment credit to the Contract Price for the Owner's estimated value of the subject item plus remuneration for associated damages and inconvenience.
  - .4 Provision of a suitable substitute Product in place of the defective Product.
  - .5 Substituted Products will be required to be commissioned and audited and undergo the same scrutiny as described for commission testing and audit testing described above.

**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 31 - Commissioning (Cx) Plan.

- .2 For Cx responsibilities refer to Section 01 91 31 - Commissioning (Cx) 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 building systems are constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .6 Consultant will issue Interim Acceptance Certificate when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Consultant.
  - .2 Equipment, components and systems have been commissioned.
  - .3 O&M training has been completed.

#### **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 non-functional system, including related systems as deemed required by Consultant, 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 Consultant.
    - .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 Consultant.
  - .7 Have Cx schedules up-to-date.
  - .8 Ensure systems have been cleaned thoroughly.
  - .9 Complete TAB procedures on systems, submit TAB reports to Consultant for review and approval.
  - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Consultant in writing of discrepancies and deficiencies on finished works.

## **1.6 CONFLICTS**

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

## **1.7 SUBMITTALS**

- .1 Submittals: in accordance with Section 21 05 01 Mechanical General Requirements
  - .1 Submit no later than 2 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 Consultant for changes to submittals and obtain written approval at least 2 weeks prior to start of Cx.
  - .3 Submit proposed Cx procedures to Consultant where not specified and obtain written approval at least 2 weeks prior to start of Cx.
  - .4 Provide additional documentation relating to Cx process required by Consultant.

## **1.8 COMMISSIONING DOCUMENTATION**

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and instructions for use.
- .2 Consultant to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Consultant.

## **1.9 COMMISSIONING SCHEDULE**

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section [01 32 16.07 - Construction Progress Schedules - Bar (GANNT) 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 16.06 - Construction Progress Schedule - Critical Path Method (CPM)[01 32 16.07 - Construction Progress Schedules - 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 16.06 - Construction Progress Schedule - Critical Path Method (CPM) 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart. Consultant 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 the Contractor Commissioning sub-contractor who will record and distribute minutes.

**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 Consultant to review report from Contractor's Cx Agent 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 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Consultant.
  - .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.
- .2 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.
- .3 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 Consultant after distinct phases have been completed and before commencing next phase.
- .4 Document required tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Consultant. 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 Consultant.

- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Consultant.
- .3 If evaluation report concludes that major damage has occurred, Consultant shall reject equipment.
  - .1 Rejected equipment to be removed 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 Consultant 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 Consultant 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 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 Consultant at least 2 weeks prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

**1.19 INSTRUMENTS / EQUIPMENT**

- .1 Submit to Consultant 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 Equipment as required to complete work.

**1.20 COMMISSIONING PERFORMANCE VERIFICATION**

- .1 Carry out Cx under accepted simulated operating conditions, over entire operating range, in all modes.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

**1.21 WITNESSING COMMISSIONING**

- .1 Consultant 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 Consultant within 5 days of test and with Cx report.

**1.23 REPEAT VERIFICATIONS**

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

**1.24 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.

**1.25 DEFICIENCIES, FAULTS, DEFECTS**

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

**1.26 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 Consultant.

**1.27 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.

**1.28 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS**

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

**1.29 OCCUPANCY**

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

**1.30 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 Consultant.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

**1.31 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.

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

**1.2            REFERENCES**

- .1    Public Works and Government Services Canada (PWGSC)
  - .1    PWGSC - Commissioning Guidelines CP.4 -3rd edition-03.
  - .2    CSA Z320 Building Commissioning Standard.
- .2    Underwriters' Laboratories of Canada (ULC)

**1.3            GENERAL**

- .1    Provide fully functional HVAC, electrical and DDC control systems.
  - .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 Owner/Investor's design 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 DFO – Department of Fisheries and Oceans
  - .4 EMCS - Energy Monitoring and Control Systems.
  - .5 MSDS - Material Safety Data Sheets.
  - .6 PI - Product Information.
  - .7 PV - Performance Verification.
  - .8 TAB - Testing, Adjusting and Balancing.
  - .9 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 100% completed within 3 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.
- .2 Submit completed Cx Plan to Consultant and obtain written approval.

#### **1.5 REFINEMENT OF CX PLAN**

- .1 During construction phase, the Commissioning Manager shall 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 2 weeks during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Consultant 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 Consultant to maintain overall responsibility for project and is primary point of contact between members of commissioning team.

- 
- .2 Commissioning Manager will select Cx Team consisting of following members:
    - .1 DFO Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
    - .2 Commissioning Manager: ensures Cx Quality Assurance activities are carried out to ensure delivery of a fully operational project including:
      - .1 Preparation & 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 Consultant is responsible for:
      - .1 Organizing Cx to ensure work is done in accordance with the Contract Documents.
      - .2 Monitoring operations Cx activities.
      - .3 Witnessing, certifying accuracy of reported results.
      - .4 Witnessing and certifying TAB and other tests.
      - .5 Ensuring the BMM is developed and provided
      - .6 Ensuring implementation of final Cx Plan.
      - .7 Performing verification of performance of installed systems and equipment.
      - .8 Ensuing proper implementation of Training Plan.
    - .4 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
      - .1 Testing.
      - .2 TAB.
      - .3 Performance of Cx activities.
      - .4 Delivery of training and Cx documentation.
      - .5 Assigning one person as point of contact with Consultant 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's representative.
    - .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 Changes to heating or cooling loads beyond scope of EMCS.
      - .2 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
      - .3 Redistribution of electrical services.
      - .4 Modifications of fire alarm systems.
      - .5 Modifications to voice communications systems.
  - .7 Provide names of participants to Consultant and details of instruments and procedures to be followed for Cx 2 weeks prior to starting date of Cx for review and approval.

**1.8 EXTENT OF CX**

- .1 Commission mechanical systems and associated equipment:
  - .1 Air source Heat Pumps
  - .2 Exhaust Fan
  - .3 Digital Controls systems
- .2 Commission electrical systems and equipment:
  - .1 Equipment Power Supplies:
  - .2 Enable/Disable control systems for existing baseboard heaters

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**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 WHMIS information.
  - .4 MSDS data sheets.
  - .5 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

**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 of following witnessed by the Consultant or DFO representative:
    - .1 Two new air source heat pumps.
    - .2 One new ventilation exhaust fan.
    - .3 New baseboard heater control valves.
    - .4 Fume Hood monitoring.
    - .5 New DDC control systems.
  - .10 Training Plans.
  - .11 Cx Reports.

- .12 Prescribed activities during warranty period.
- .4 Consultant to witness and certify tests and reports of results provided to Consultant.
- .5 PWGSC Quality Assurance Commissioning Manager 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 Commissioning manager prior to permission to start up and rectification of deficiencies to Consultant's satisfaction.
  - .2 Commissioning manager to use approved check lists.
  - .3 Consultant may, at their discretion, monitor some 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 Consultant and does not form part of Cx specifications.
  - .6 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 Consultant.
  - .2 DDC/EMCS:
    - .1 DDC/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 Consultant 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".
- .3 Pre-Cx activities - ELECTRICAL:
  - .1 Low voltage distribution systems under 750 V:
    - .1 Requires independent testing agency to perform pre- energization and post-energization tests.

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**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:
- .3 Commissioning sub-contractor to monitor all of these start-up activities.
  - .1 Rectify start-up deficiencies to satisfaction of Consultant.
- .4 Performance Verification (PV):
  - .1 Approved Cx Agent to perform.
    - .1 Repeat when necessary until results are acceptable to Consultant.
    - .2 Use procedures modified generic procedures to suit project requirements.
    - .3 Consultant to witness and certify reported results using approved PI and PV forms.
    - .4 Consultant to approve completed PV reports and provide to Owner.
    - .5 Consultant 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 commissioning sub-contractor and approved by Consultant.
- .2 Consultant to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.
- .4 Consultant to witness, certify reported results of, Cx activities and forward to Consultant.
- .5 Consultant 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 Commissioning subcontractor, using procedures developed by Commissioning subcontractor and approved by Consultant.
- .2 Tests to be witnessed by Consultant and documented on approved report forms.
- .3 Upon satisfactory completion, Commissioning subcontractor to prepare Cx Report, to be certified by Consultant and submitted to the Owner for review.
- .4 Integrated systems to include:
  - .1 Two heat pumps, three heat pumps, ventilation fan, unit heaters, radiant heaters and their respective control systems.
- .5 Identification:

- .1 In later stages of Cx, before hand-over and acceptance Consultant, Contractor, Project Manager, Property Manager and Commissioning sub-contractor to co-operate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

**1.15 INSTALLATION CHECK LISTS (ICL)**

- .1 Refer to Section 01 91 33 - Commissioning (Cx) 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 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

**1.17 PERFORMANCE VERIFICATION (PV) REPORT**

- .1 Refer to Section [01 91 33 - Commissioning (Cx) 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 Consultant 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: 2 weeks after contract award, and before construction starts.
    - .3 Cx agents' credentials: 3 weeks before start of Cx.
    - .4 Cx procedures: 3 weeks after award of contract.
    - .5 Cx Report format: 3 weeks after contract award.
    - .6 Submission of list of instrumentation with relevant certificates: 2 weeks before start of Cx.
    - .7 Notification of intention to start TAB: 2 weeks before start of TAB.
    - .8 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
    - .9 Notification of intention to start Cx: 14 days before start of Cx.
    - .10 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
    - .11 Implementation of training plans.

- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.
- .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 Consultant, Contractor, Contractor's Cx agent, and Property Manager will monitor progress of Cx against this schedule.

**1.20 CX REPORTS**

- .1 Submit reports of tests, witnessed and certified by Commissioning sub-contractor to Consultant 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 Consultant.

**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 FINAL SETTINGS**

- .1 Upon completion of Cx to satisfaction of Consultant 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    Includes 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 Consultant 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 Consultant. 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 Consultant'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 to record 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 Consultant's approval.

### **1.5 SAMPLES OF COMMISSIONING FORMS**

- .1 Consultant 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 provided, after the contract has been awarded.

### **1.6 COMMISSIONING FORMS**

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
  - .1 Consultant provides Contractor project-specific Commissioning forms with Specification data included, to be used by the Commissioning Agent and refined during the commissioning process.
  - .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 Contractor verifies reported results.
  - .8 Forms to bear signatures of recording technician and reviewed and signed off by Consultant.
  - .9 Contractor submits immediately after tests are performed.
  - .10 Contractor report results in true measured SI unit values.
  - .11 Contractor provides Consultant with originals of completed forms.
  - .12 Contractor maintains 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 21 05 01 Mechanical General Conditions

**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                REFERENCES**

- .1    Canadian Standards Association (CSA International)
  - .1        CSA S350-M1980(R1998), Code of Practice for Safety in Demolition of Structures.

**1.2                SUBMITTALS**

- .1    Prior to beginning of Work on site submit detailed Waste Reduction Workplan in and indicate:
  - .1        Descriptions of and anticipated quantities of materials to be salvaged reused, recycled and landfilled.
  - .2        Name and address of waste facilities.

**1.3                SITE CONDITIONS**

- .1    Do not proceed until written instructions have been received from Consultant and approval to proceed is received from the Facility Manager.

**Part 2            Products**

**2.1                NOT USED**

- .1    Not used.

**Part 3            Execution**

**3.1                SCOPE OF DEMOLITION**

- .1    Removal of air conditioning units, redundant ductwork, wiring, refrigerant lines, controls and HVAC equipment that is to be upgraded/replaced.
- .2    Removal of the wall material removed to install the new equipment.

**3.2                PREPARATION**

- .1    Inspect building with Facility Manager and verify extent and location of items designated for removal, disposal, and items to remain.
- .2    Locate, close isolating valves, remove water and drain piping, electrical and control wiring connections to the exhaust fan and heat pumps.
- .3    Locate, isolate and disconnect components of HVAC equipment to be upgraded.
- .4    Remove and replace components while maintaining building heating systems and HVAC equipment in operation during occupied hours
- .5    Provide temporary enclosures, signage and barriers as directed by the Facility Manager.

- .6 Comply with Work Safe BC regulations.

### **3.3 SITE REMOVALS**

- .1 Remove the air conditioning units, redundant ductwork, insulation, wiring and associated equipment for disposal.
- .2 Remove packaging and pallets for new HVAC equipment.

### **3.4 DEMOLITION**

- .1 When the HVAC equipment has been removed, prepare surfaces for installation of new equipment.
- .2 Make good any damages to the surfaces of wall, ceilings and floors.
- .3 Provide access panels as required to access ceiling spaces to install or modify equipment.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

.1            Definitions:

- .1            Asbestos-Containing Materials (ACMs): materials that contain 0.5 per cent or more asbestos by dry weight and are identified under Existing Conditions including fallen materials and settled dust.
- .2            Dangerous Goods: product, substance, or organism specifically listed or meets hazard criteria established in Transportation of Dangerous Goods Regulations.
- .3            Hazardous Material: product, substance, or organism used for its original purpose; and is either dangerous goods or material that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when released into the environment.
- .4            Hazardous Waste: hazardous material no longer used for its original purpose and that is intended for recycling, treatment or disposal.

.2            Reference Standards:

- .1            Canadian Environmental Protection Act, 1999 (CEPA 1999)
  - .1            Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149).
- .2            Department of Justice Canada (Jus)
  - .1            Transportation of Dangerous Goods Act, 1992 (TDG Act) [1992], (c. 34).
  - .2            Transportation of Dangerous Goods Regulations (T-19.01-SOR/2001-286).
- .3            Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1            Material Safety Data Sheets (MSDS).
- .4            National Research Council Canada Institute for Research in Construction (NRC-IRC)
  - .1            National Fire Code of Canada-2005.

**1.2                DELIVERY, STORAGE AND HANDLING**

- .1            Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2            Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3            Transport hazardous materials and wastes in accordance with Transportation of Dangerous Goods Act, Transportation of Dangerous Goods Regulations, and applicable provincial regulations.
- .4            Storage and Handling Requirements:
  - .1            Co-ordinate storage of hazardous materials with Owner and abide by internal requirements for labelling and storage of materials and wastes.

- .2 Store and handle hazardous materials and wastes in accordance with applicable federal and provincial laws, regulations, codes, and guidelines.
- .3 Store and handle flammable and combustible materials in accordance with National Fire Code of Canada requirements.
- .4 Solvents or cleaning agents must be non-flammable or have flash point above 38 degrees C.
- .5 Store flammable and combustible waste liquids for disposal in approved containers located in safe, ventilated area. Keep quantities to minimum.

### **1.3 EXISTING CONDITIONS**

- .1 Reports and information pertaining to ACMs within the facility, ASBESTOS CONTAINING MATERIAL, as available, will be provided available on request.
- .2 Based on a preliminary review, it appears that the work will not disturb any ACMs within the facility. However, it is the responsibility of the Contractor to review the Site Asbestos Inventory Report to confirm that no ACM's will be disturbed by the work.
- .3 Notify the Owner of material discovered during Work and not apparent from report. Do not disturb such material. Testing and subsequent abatement as required will be carried at the owner's expense.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Description:
  - .1 Bring on site only quantities of hazardous material required to perform Work.
  - .2 Maintain MSDS in proximity to where materials are being used. Communicate this location to personnel who may have contact with hazardous materials.

## **Part 3 Execution**

### **3.1 CLEANING**

- .1 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal
  - .1 Dispose of hazardous waste materials in accordance with applicable federal and provincial acts, regulations, and guidelines.
  - .2 Recycle hazardous wastes for which there is approved, cost effective recycling process available.
  - .3 Send hazardous wastes to authorized hazardous waste disposal or treatment facilities.
  - .4 Burning, diluting, or mixing hazardous wastes for purpose of disposal is prohibited.

- .5 Disposal of hazardous materials in waterways, storm or sanitary sewers, or in municipal solid waste landfills is prohibited.
- .6 Dispose of hazardous wastes in timely fashion in accordance with applicable provincial regulations.
- .7 Minimize generation of hazardous waste to maximum extent practicable. Take necessary precautions to avoid mixing clean and contaminated wastes.

**END OF SECTION**

**Part 1            General**

**1.1                SCOPE**

- .1        This specification, together with the other Contract Documents, describes the requirements and quality of work for the removal of two air conditioning units and related equipment, the supply and installation of new heat pumps, exhaust fan and HVAC equipment and turnover of complete operating systems as shown on the drawings and called for in these specifications.
- .2        The Work shall include but not be limited to the supply of all labour, materials, equipment and supervision to complete the Work as shown on the Drawings and as required by the Contract Documents.
- .3        Existing security, smoke control, fire alarms and monitoring shall be uninterrupted by the installation.
- .4        Carefully examine local conditions affecting the Work and building site, together with all other trades to make sure that Work under Specification and as shown on Drawings can be satisfactorily carried out without changes. Work of all trade Divisions shall be examined, before commencing Work, and any defect or interference affecting Work shall be reported at once.
- .5        No allowance will be made for any expense incurred through failure to make these examinations or on account of any condition on site or item existing thereon which was visible or known to exist at the time Tender for Work was submitted.
- .6        Drawings as provided, showing the Work, do not show every structural and architectural detail and are diagrammatic only. Take any information involving accurate measurements of the building. Refer to the Owner's Architect or Design Consultant's drawing for the approximate location of all existing equipment, piping, ductwork, wiring, controls and other systems.

**1.2                DEFINITIONS**

- .1        Where the words "indicated", "designated", "shown", "noted", "listed", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to is "indicated", "designated", "shown", "listed" or "noted" in the Specifications or on the Drawings.
- .2        Wherever the words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected" or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "approved by", "satisfactory to", "as directed by", "submitted to", "permitted by" or "inspected by" the Owners Representative.
- .3        The term "provide" where used, shall be understood to include labour, materials and services necessary to supply and install the item or work referred to.

- .4 In the Contract Documents the following definitions apply:
- (a) “Work” includes the whole of the works, materials, matters and things required to be done, furnished and performed by the Contractor under the Contract Documents.
  - (b) “Substantial Performance” means the work is ready for use or is being used for the purpose intended and has passed the test procedure in accordance with the Project Specification and is so certified by the Owner’s Representative.
  - (c) “Total Performance” shall mean that the entire work has been performed to the requirements of the Contract Documents and is so certified by the Owner’s Representative.

### **1.3 EXAMINATION OF SITE**

- .1 Visit the site before tendering and examine all local and existing conditions on which the work is dependent.
- .2 No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit the site.
- .3 When the contract documents do not contain sufficient information for the proper selection of equipment for bidding, notify the design authority during the tendering period. If clarification is not obtained, allow for the most expensive arrangement. Failure to do this shall not relieve the contractor of responsibility to supply the intended equipment.
- .4 Check drawings of all trades and survey the site to verify space availability for the installation. Co-ordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent without written approval.
- .5 The dimensions of existing work shown on the drawings are approximate and the Contractor must take actual measurements before ordering materials, equipment and the like. Failure to comply with this requirement will make the Contractor fully responsible for replacing such material or equipment at no extra cost to the contract.
- .6 The dimensions of existing work shown on the drawings are approximate and the Contractor must take actual measurements before ordering materials, equipment and the like. Failure to comply with this requirement will make the Contractor fully responsible for replacing such material or equipment at no extra cost to the contract.

### **1.4 LIABILITY**

- .1 Assume responsibility for laying out work and for damage caused by improper execution of work.
- .2 Protect finished and unfinished work and occupants furniture and equipment from damage.
- .3 Take responsibility for condition of materials and equipment supplied and protect until work is completed and accepted.

- .4 The Owner shall have recourse in tort for any negligent action by the contractor or his representatives.
- .5 Contractor to make good all damage, painting, flooring, concrete anchors, etc.

**1.5 DRAWINGS**

- .1 The drawings which accompany this specification shall be read in conjunction with existing architectural, electrical, sprinkler and structural drawings. The Contractor will be required to make, without charge, any necessary modifications in the arrangement of piping, ductwork, or electrical service and wiring, to accommodate structural conditions or the work of the trades.
- .2 The drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work. Do not scale the drawings. All services to be concealed unless otherwise noted.
- .3 The Contractor, when estimating, shall visit the site and make himself familiar with all existing conditions and allow for same in his tender.
- .4 The contract drawings shall not be used for the prefabrication of piping, ductwork, plenum work, etc. Where the Contractor prefabricates certain sections of the work, he shall be responsible for taking all required field measurements and surveys, to check out and make due allowance for the work of other trades, structure, and available space, and be fully responsible for his work.
- .5 The Contractor shall be responsible for the detailed layout of all equipment, bases, ductwork and piping, etc. He shall take all required field measurements and surveys and lay out all equipment, bases, piping and duct runs accurately. Equipment locations and piping and duct runs shall generally conform to the contract drawings. Where required, he shall produce field shop drawings to show the positions of all equipment, bases and runs with detailed dimensions of equipment, bases, anchor bolts, etc.

**1.6 PERMITS CODES AND APPROVALS**

- .1 The Contractor shall obtain all permits, pay fees therefore that are required by local municipal, provincial and federal authorities. Do Work in compliance with all laws, rules, ordinances and regulations having jurisdiction.
- .2 Provide certificates, inspection reports for inclusion in the maintenance manuals, as evidence that the Work conforms with the laws and regulations of the authorities having jurisdiction.

**1.7 CODES GOVERNING REGULATIONS**

- .1 The Work under this contract shall conform to but not be limited to the requirements of the following codes, regulations and standards:
  - ) The National Building Code (NBC)
  - ) The local Building Code
  - ) The BC Building Code 2012
  - ) The Workers' Compensation Act

- ) The Canadian Electrical Code
- ) Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulations
- ) The Canadian Standards Association
- ) National Fire Protection Association

**1.8 SITE CO-OPERATION**

- .1 Co-operate at all times with the Owner's Representative in all matters concerning scheduling of work, necessary interference with normal working routine, access to work areas, placing and removing of temporary barricades, and protection.
- .2 All work in office space shall be undertaken outside of regular business hours unless otherwise approved in advance (minimum 24 hours) by the Owner's Representative.
- .3 Electrical power shutdown to facilitate connection of equipment shall be done in co-operation with the Owner's Representative during off hours or during weekends.
- .4 The Contractor shall at all times during performance of the Work, keep the Site clean and presentable with clean up at the end of each shift. For that purpose shall from time to time, remove from the Site all rubbish and debris accumulating from the Work, and upon completion of the Work shall leave the Site in a clean and presentable condition.
- .5 Each trade shall protect its own and other trade's finished and unfinished work from damage, due to the carrying out of its work. Cover floors, office furnishings and other work with tarpaulins, if required, for this purpose. Each trade shall assume responsibility for repairing damage to floor and wall surfaces and office equipment resulting from its failure to provide such protection. Carry out such repairs in a satisfactory manner without expense to the Owner.
- .6 Work of each trade shall be laid out so that it does not conflict with Work under other related contracts. Make good damage to the Owner's property or other trade's work, caused by improper locating or carrying out of Work. Co-ordinate related work with other contractors such that equipment downtime is minimal and only occurs between the hours of 6 PM to 6 AM on weekdays.
- .7 Install services and equipment which are to be concealed, as close as possible to building structure for accessibility and so that necessary furring if required can be kept to minimum dimensions.

**1.9 SIGNS AND PUBLICITY**

- .1 Neither the Contractor nor anyone directly or indirectly employed by them, shall post any site signs, nor release any publicity reports, photographs, sketches, plans or other information, orally or in writing, concerning the work performed or to be performed, without the prior written acceptance of the Owner's Representative.

**1.10 RECORDS TO BE KEPT BY CONTRACTOR**

- .1 The Contractor shall, for a period of two years from the date of Total Performance, maintain and keep full records, vouchers, other writings and information in respect of his estimates and actual cost of the work, and shall make them available for copy, audit or inspection by the Owner's Representative.

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**1.11 MATERIALS**

- .1 All materials furnished and entering into the installation shall be new and of the best quality. Where two or more units of the same type of equipment are required, they shall be the product of the same manufacturer. All equipment and materials shall be installed in accordance with the manufacturer's recommendations.
- .2 Preference shall be given to products from BC for all materials and supplies used in or on the construction of the building or site where price, quality and service are equal. Decision as to the equality of materials or supplies shall be made by the Owner, based on the recommendations of the Consultant.

**1.12 SUBSTITUTION OF EQUIPMENT**

- .1 The Contractor shall base his tender on the goods specified or he may submit a tender using alternative material, provided such alternative material receives the written approval of the consultant prior to closing of tenders. Requests must be submitted at least five full working days prior to the closing of tenders for this trade.
- .2 Where the Contractor proposes to use alternative material which requires any redesign, changes, or additions to the structure, piping, ductwork, wiring, etc., the cost of all such redesign, new drawings, changes, and additions required shall be borne by the Contractor.

**1.13 FIRE STOPPING**

- .1 It shall be the responsibility of the Contractor to provide fire stopping at all duct, pipe, wiring and conduit penetrations of fire rated walls and floors where such penetrations are the result of the work of this Division. All materials must meet the smoke and flame spread requirements of the current edition of the BC Building Code and be ULC approved for this application.

**1.14 MECHANICAL APPROVAL LIST**

- .1 Tenders for the mechanical work shall be based on equipment, materials, firms, etc., as specified or scheduled, or on those named as acceptable alternatives on the mechanical Approval List or in the specification.
- .2 To receive approval for other alternate material or equipment, refer to clause "Substitution of Equipment". Substitute materials and equipment will be deemed as acceptable providing such material is of the same type, quality, capacity, performance rating, size, construction, and characteristics which, in the opinion of the Consultant, are equal to that specified.
- .3 It is the responsibility of those suppliers who are not specified or scheduled, but who are named as acceptable alternatives in the mechanical Approval List or the specification to check and assure that their equipment meets all the requirements of the specifications and is of a size to fit into the allocated space without hindering access for operation and maintenance. Where the Contractor proposes to use alternative material or equipment which requires any redesign, changes, or additions to the structure, piping, ductwork, wiring, equipment layout, etc., the cost of all such redesign, new drawings, changes, and additions that are required shall be borne by the Contractor.

- .4 Where, in the opinion of the Consultant, any alternative equipment or materials proposed do not meet the requirements of the specification, are of inadequate capacity, or are too large or are of a size unsuitable to the space allocated, such equipment and material will be rejected for use on this project.
- .5 Suppliers shall not group or bulk different types of equipment or materials together and quote lump sum prices.
- .6 Within 15 days of award of contract, the Contractor shall furnish to the Consultant for approval three (3) copies of a complete list of suppliers, equipment, materials, and sub-trades he intends to employ on the job. One name shall be submitted for each item listed on the mechanical Approval List. If any equipment or materials are not that specified or an approved alternative, or in the opinion of the Consultant are not suitable for the project, it shall be rejected, and the Contractor shall replace it with approved acceptable products.
- .7 If the above list is not received by the Consultant within the stated time, the Contractor shall supply all equipment and materials exactly as specified or scheduled.

#### **1.15 MECHANICAL EQUIPMENT SCHEDULES**

- .1 The equipment schedules are to be read in conjunction with the pertinent sections of the specification. The specification sections and the schedules are complimentary to one another.
- .2 The equipment make and size shown in the schedules is that which the project design and drawings are based on and for which space in the building design has been allocated.
- .3 Where alternative equipment makes have been shown in the specification equipment sections, the Mechanical Approval List, or are approved during the tender process, it shall be the Contractor's and equipment suppliers' responsibility to assure that the alternate equipment meets all the requirements of the specification, is of adequate size and capacity, has similar electrical characteristics, is suitable for the duty intended, and is of a physical size and shape to fit into the space which has been allocated in the system design. Where any alternate equipment fails to meet any of the criteria for the use of alternate equipment spelled out in this specification, it shall be rejected for use in the project.

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**1.16 PROJECT RECORD DRAWINGS**

- .1 The Contractor shall maintain on-site, one complete set of white prints of the mechanical, plumbing, sprinkler and site service drawings. These drawings shall be maintained on-site, in good condition, to record all changes, revisions, addenda, etc. They shall not be used for any other purpose. This site record set of drawings shall be kept up to date and shall be available on-site at all times for review by the Consultant.
- .2 The Contractor shall neatly record, on the site record set of drawings, all revisions, changes and addenda to the original contract drawings. All revisions shall be neatly drawn in red pencil. All changes in invert elevations shall be noted and recorded.
- .3 The location and identification number of all concealed mechanical equipment controls, instruments, switches, transducers, etc., shall be recorded on the site record drawings.
- .4 Maintain one contract drawing white print on site, solely for the purpose of recording, in red, any change and/or deviation from the contract drawing as it occurs.
- .5 Submit a copy of as-installed drawings to the Consultant upon substantial completion of this contract.
- .6 Mechanical Contractor shall submit Mechanical Record drawings to conform to PWGSC CADD drawing standards. CAD drawings shall be completed by the contractor or by arrangement with the consultant, to transfer all changes to amend the CAD files. (Fee by Prism for this service will be approximately \$200/drawing).
- .7 Include all details and revisions reflecting As-Built conditions to the Mechanical System. Label each drawing in the lower right corner in letters of at least 12mm (1/2") high as follows: "RECORD DRAWING", Contractors name and date.
- .8 Provide HVAC control schematic drawing and site specific wiring diagrams for HVAC controller boards and integration with existing control systems.
- .9 Deliver CAD files on a CD disc with project name and date and one set of plots to the Consultant and one in each of the Maintenance Manuals.

**1.17 MAINTENANCE MANUALS**

- .1 The Contractor shall furnish and pay for three (3) complete sets of operating and maintenance manuals for the installation. The manuals shall be prepared by a specialized company or approved agency. The Contractor shall also provide a scanned copy of the O & M manual (soft copy) on a computer disk(s) or on a thumb drive memory stick. The Cost of the manuals shall be included in the contract price.
- .2 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Engineer one (1) week prior to final inspection. The maintenance manuals shall be bound in 3 post binders. Each volume clearly titled: "DFO Cultus Lake Laboratory HVAC Upgrades Manual", complete with project name and building address and name.
- .3 The manual shall be divided into indexed sections as follows:
  - (a) **Binder Cover and Binder Edge** - Building Name, address, project name, project number (Prism# 2016185), completed date.

- (b) **Title Page** - O&M Manual for... Building name, address, date, general contractor information: name address, phone number. Consultant name address, phone number. Table of contents indicates each binder's contents,
- (c) **Index and Tabs:** Dividers with permanently marked tabs separate each section and sub section, Tab labels typed, not hand written Main tab for each specification section.
- (d) **Tab A-** Signed letter of Warranty to include: dated, project name, project number (Prism#), location, warranty start date and end, to be from date of substantial, declared by Consultant, all warranties to be included from all contractors in this sections and extended warranties.
- (e) **Tab B** - Contact information for all sub-contractors and suppliers. Contractor Information: Name, address, telephone number of manufacturer, installing contractor, 24-hour number for emergency service for all equipment in this section identified by equipment. Valve and equipment code list.
- (f) **Tab C - All Reports** - Copies of all TAB reports, pre-functional tests, start up reports, completed performance verification forms(found in the Tender Documents), cabling verifications, ESA certification ,TSSA certification, fire alarm certifications, seismic certification, all permits i.e. electrical, building ,plumbing etc.
- (g) **Tab D** - As Build Drawings-marked up by contractor, changes marked in red to also be given to Consultant
- (h) **Tab E** - Sequence of Operation-outline how the systems installed were designed to work.  
  
Accurate Sequences of Operation, with detailed instruction in proper sequence, for each mode of operation.  
-Emergency Operation: Functions of equipment that can be operated while other functions disabled. Included only for alternate abnormal operations that can follow when there is a partial failure, malfunctioning of components, or other unusual condition.  
-Shutdown Procedure: Instructions for stopping and securing the equipment after operation. If a particular sequence is required, step-by-step instructions given in that order.
- (i) **Tab F** - CMMS Data Sheets-all equipment which is to be deleted, removed, added , or replaced is to have a CMMS inventory sheet completed and included in the O&M Manual. These documents are included at the end of this Section.
- (j) **Tab G** - Shop Drawings-Copy of all reviewed "by the Consultant" shop drawings.
- (k) **Tab H** - -Copy of specific service and maintenance manuals. Preventative and corrective maintenance, with service procedures and schedules.  
  
-Schedule for preventive maintenance in a printed format and electronic format compatible with Owner's system.  
- Recommended frequency of performance for each preventive maintenance task, cleaning, inspection and scheduled overhauls or reconditioning.

- Cleaning: Instructions and schedules for all routine cleaning and inspection recommended, including recommended cleaners and lubricants.

- Inspection: Periodic inspection of equipment required for operation, cleaning or other reasons, with items to be inspected indicated and inspection criteria given for motors, controls, filters, and any other maintenance items.

- Instructions for minor repairs or adjustments required for preventive maintenance routines.

- Listing of any special tools required to service or maintain the equipment.

- (1) **Last Tab** – Misc. items i.e. – Special Requirements for equipment, not to be used for reports.

### **1.18 GUARANTEE**

- .1 The Contractor shall guarantee that all apparatus shall develop the capacities and characteristics specified. The guarantee period shall be 12 months from the date of substantial completion of the general contract for the project as established by the owner.
- .2 During this period, any defects in materials, workmanship, or performance shall, without cost to the owner, be remedied within a reasonable length of time of notice being received from the owner. The Contractor shall undertake all service or adjustment required to the equipment during this period as part of the guarantee.
- .3 The guarantee period shall not be shortened, or the terms altered, due to the use of the owner's equipment before substantial performance is accepted.

### **1.19 WORK IN EXISTING BUILDING**

- .1 Work includes changes to the existing occupied operational building and may include changes of old and new construction to suit as shown or as specified herein.
- .2 Obtain approval from the Owner's Representative prior to penetrating any structural surfaces including roof and floor slabs. Obtain from the Owner's Representative approval of locations of all penetrations prior to commencing work. Contractor shall replace/repair any building services which are damaged due to this construction (example: drilling through concrete floors) at no extra cost.
- .3 Carefully route new conduits and other new services so that they do not interfere with existing installation. Arrange and pay for any necessary relocation of existing conduit, cable tray, bus duct or any other services required for the proper installation of new Work, regardless of whether the conduit, tray or duct to be moved is the work of trade doing new Work.
- .4 The removed equipment and material shall become the property of the Contractor and shall be removed from site unless otherwise requested by the Owner's Representative.
- .5 All work on site shall be co-ordinated with the Owner's Representative as to minimize disruptions. Installation of equipment must take place outside of regular business hours. Work taking place outside of the occupied areas that does not involve power interruptions may occur during the day with prior approval from the Owner's Representative.

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**1.20 CONTINUITY OF EXISTING SERVICES**

- .1 Keep existing building in operation at all times with minimum length of shut-down periods.
- .2 Obtain permission of the Owner before shutting down or disconnecting electrical and fire protection services. Co-operate with the Owner and other contractors on the job and provide necessary services so that existing building can be kept in operation at all time. Include in Tender Price for overtime that may be required to tie-in services at night or on weekends.
- .3 The Owner reserves the right to complete and/or repair any work that is not in operating condition, beyond scheduled shut downs, in order to maintain the Owner's operation.
- .4 readings of shafts.

**1.21 SHOP DRAWINGS**

- .1 The Contractor shall email one set of shop drawings in PDF format to the Consultant for review prior to ordering.
- .2 Note each shop drawing with the following information:
  - .3 Manufacturers and Suppliers name
  - .4 Catalogue Model Number
  - .5 Name and Trade supplying item
  - .6 Project Identification Number
  - .7 Number identifying item on Contract Drawing and/or in Specification
  - .8 Operating and maintenance clearances
  - .9 Detailed drawings of bases, supports, and anchor bolts
  - .10 Acoustical sound power data for pumps and fans
  - .11 Points of operation on performance curves
  - .12 Manufacturer to certify current model production
  - .13 Certification of compliance to applicable codes
- .14 Each shop drawing shall be checked and stamped as being correct by the trade purchasing the item and by the Contractor before the drawing is submitted. If the above requirements are not complied with, shop drawings will be rejected and returned forthwith.
- .15 When drawings are accepted, the said acceptance does not in any way relieve the Contractor of his responsibility or the necessity of furnishing materials or performing work as required by the drawings and Project Specification.
- .16 No factory or field fabrication shall commence nor shall any materials be delivered to the site before the drawings are accepted by the Owner's Representative.

**1.22 REDUNDANT EQUIPMENT REMOVAL**

- .1 The Contractor will remove all redundant equipment and dispose of or hand it over to the Owner's Representative as directed.
- .2 Where existing equipment is removed, building wall, ceiling and floor components and affected equipment are to be restored to match surrounding for structure, appearance, and function.
- .3 All existing accessible wiring and piping that is no longer required in the new installation shall be disconnected and removed.

**1.23 EQUIPMENT AND OPERATION**

- .1 All equipment operated by the Contractor prior to final acceptance of the building shall be maintained by the Contractor. All equipment shall be lubricated by the Contractor using correct lubricant at regular intervals.
- .2 All lubricating positions on equipment shall be arranged or extended to accessible locations by the Contractor.
- .3 Three sets of any keys, operators, special tools, etc., required for the operation and maintenance of the systems shall be turned over to the Owner's Representative.

**END OF SECTION**

**Part 1            General**

**1.1                SCOPE OF WORK**

- .1      Cleaning of the distribution ductwork for air handling systems serving HPI-1 and HPI-2 from the air handling units/intake, through to the supply diffusers.
- .2      Work shall be scheduled when the building is unoccupied.
- .3      Allow for 1 hour cleanup in the areas worked at the end of each shift.
- .4      Include for the removal and reinstatement of the ceiling tiles to access the ductwork and protection of work areas with plastic/drop cloths.
- .5      Work shall include installation of access panels in the duct systems for cleaning.

**1.2                REFERENCE DOCUMENTS**

- .1      American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE ANSI/ASME B1.20.1-1983(R2001), General Purpose (Inch).
  - .1      ASHRAE 52.2-2007 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- .2      Sheet Metal and Air Conditioning National Contractors Association (SMACNA)
  - .1      SMACNA IAQ Guideline for Occupied Building Under Construction

**1.3                SUBMITTALS**

- .1      Perform duct system cleaning using a firm specializing in this type of work. Submit the following information prior to commencing work:
  - .1      List of at least two projects of similar size and scope completed by the firm.
  - .2      Name of the superintendent that will be responsible for executing the work and his experience with projects of this scope.
- .2      Submit an outline of the work scope for each air handling system with procedures, equipment, materials and schedule prior to commencing work.
- .3      Submit a Certificate of Completion stating that duct cleaning has been completed as specified in this section.

**1.4                DEFINITIONS**

- .1      Air system: includes central equipment; fans, coils, dampers, turning vanes, grilles, diffusers, high, medium and low pressure supply ductwork that is associated with an air handling system.

**1.5                PROTECTION**

- .1      Protect furniture, equipment and flooring in close proximity to the work area with clean protective coverings.

- .2 Take precautions to ensure that dust and debris do not spread outside of duct system during the cleaning process.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Temporary Filters: 3 ply filter element to protect equipment during cleaning operation, meeting either of the following:
  - .1 35% dust spot efficiency to ASHRAE 52.1.
  - .2 MERV-8 to ASHRAE 52.2.
- .2 Access Ports Covers: reusable, positive locking cover for access ports. Maximum flame spread rating of 0. Friction fit plastic plugs and tape are not acceptable access port cover materials

### **2.2 ACCESS DOORS**

- .1 Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Install minimum 25 mm thick insulation with suitable sheet metal cover frame for insulated ductwork.
- .2 Fabricate with two butt hinges and two sash locks for sizes up to 450 mm, two hinges and two compression latches with outside and inside handles for sizes up to 600 x 1200 mm and an additional hinge for larger sizes.
- .3 Access doors shall be UL labeled.

## **Part 3 Execution**

### **3.1 ACCESS DOOR INSTALLATION**

- .1 Installation of access doors in ductwork has been specified in the following sections:
- .2 Section 23 31 30: Ductwork Accessories
- .3 Install additional access doors required to complete the duct cleaning operations specified in this section.
- .4 Install 30 mm (maximum) OD access points with covers in the following ductwork locations:
  - .1 Where required to access equipment
  - .2 On each side of all heating coils
  - .3 At all locations of internally duct mounted equipment or devices including balancing dampers, automatic dampers, damper motors and controls

### **3.2 DUCT SYSTEM CLEANING**

- .1 Clean the following air systems to remove all visible particulates:

- .1 Duct systems for HPI-1 and 2.
- .2 Install temporary filters in the following locations:
  - .1 Behind all grilles and diffusers.
  - .2 In front of all duct coils.
  - .3 At inlet of all terminal high velocity units to protect pitot openings.
- .3 Clean all ductwork, plenums, coils and air handling equipment with compressed air and mechanical agitation devices or compressed air and high power suction equipment.
- .4 Do not use mechanical brushes on acoustic lined ductwork.
- .5 Clean diffusers and grilles.
- .6 Remove all filters after a settling period of not less than two days or more than five days after vacuum procedure is complete. Ensure the number of filters removed is equal to the number of filters installed.
- .7 Seal all ductwork outlets and plenum openings with polyethylene sheet cover after duct system has been cleaned.
- .8 Mark positions of all balancing dampers prior to start of cleaning work, and return dampers to pre-cleaning positions after cleaning has been completed.
- .9 Repeat duct cleaning procedures on all duct sections found not satisfactory by independent test agency hired by the Project Manager.
- .10 Repeat duct cleaning procedures on all sections found not satisfactory by independent test agency.
- .11 Submit Certificate of Completion for each air system stating that duct cleaning and disinfection has been completed as specified in this section.

**END OF SECTION**

**Part 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 07 84 00 - Fire Stopping

**1.2 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Canadian Standards Association (CSA International)
- .3 National Fire Code of Canada (NFCC 2005)

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 21 05 01 – Mechanical General Requirements.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
  - .2 Store and handle in accordance with the manufacturer recommendations.

**Part 2 PRODUCTS**

**2.1 MATERIAL**

- .1 Fire Stopping: in accordance with Fire Stopping requirements
  - .1 Contractor to provide shop drawings of the proposed fire stopping for review.

**2.2 EXPANSION CONTROL**

- .1 All piping shall be installed so that it will in no way be strained or distorted by expansion. Anchors and expansion loops shall be provided where necessary to protect equipment and piping and regulate expansion.
- .2 Anchors and guides shall be installed wherever necessary to limit expansion and protect equipment. If on-the-job circumstances require additional changes of direction or

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additional expansion joints, loops, or guides, this Division shall be responsible for furnishing and installing same at no extra cost.

- .3 Pipe alignment guides shall be Flexonics, or approved. Guides shall be securely anchored in place to the building structure. They shall be installed as per the manufacturers' instructions. Guides shall be suitable for the pipe insulation thickness.

### **2.3 DRAINS**

- .1 All piping drains, and all condensate and equipment drains, shall be fitted with 20 mm (¾") bronze screwed ball type drain valves complete with lever handle, hose outlet, hose cap and chain, Red-White No. 5046.
- .2 All hose bibs installed on cold water supply piping shall be fitted with a Watts No. 8 backflow preventer with tamper-proof set screw.

## **Part 3 EXECUTION**

### **3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 PIPING**

- .1 All piping runs shall be fabricated in a neat and workmanlike manner, all grades shall be true and even, and all vertical piping shall be plumb.
- .2 Piping systems, in general, shall pitch upwards in the direction of flow towards air vents with a uniform grade of 25 mm (1") in 6000 mm (20'-0").
- .3 All piping shall be installed so that all water can be completely drained.
- .4 Runouts and branch lines to radiation, equipment, risers, stubs, etc., shall have a uniform grade of 25 mm (1") in 600 mm (24"). Water branches shall be taken off the top or bottom of the mains, as required, at an angle of 45° or 90°.
- .5 Each runout or branch shall be made up with swing joints and shall contain at least three elbows for flexibility. The base of each riser or stub, and the top of each drop shall be made up with a two-elbow swing joint.
- .6 All piping shall be supported independent of the equipment and shall be anchored in close proximity to the equipment to prevent strain or shock being transmitted to the equipment.

### **3.3 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.

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- .4 Install flushing bypasses to heat exchangers, sensitive pieces of equipment and as directed by manufacturers recommendations.

### **3.4 CLEARANCES**

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer and as indicated without interrupting operation of other system, equipment, components.

### **3.5 DRAINS**

- .1 Install 20 mm (¾") hose drains at each low point in the system to permit complete drainage. Access panels shall be provided to all drain valves located concealed in walls or ceilings.
- .2 Install 20 mm (¾") hose drains immediately down stream of each main zone shutoff valve at the flow and return headers in the boiler room to allow drainage of an isolated zone.
- .3 Install 20 mm (¾") hose drains immediately down stream of each main zone or sub-zone isolating shutoff valves located in mains, sub-mains and branch mains to allow drainage of all isolated sections of piping.
- .4 In the mechanical room all drains, relief and overflow lines shall be piped to floor drains.
- .5 Condensate drains from cooling coil drain pans shall be trapped and piped from the drip pan to the nearest accessible floor drain. Drains shall be minimum size 32 mm (1¼") and shall be complete with cleanouts as required.
- .6 No drain or overflow shall discharge onto any floor or roof.

### **3.6 DIELECTRIC COUPLINGS**

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

### **3.7 PIPEWORK INSTALLATION**

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main. Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

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- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
  - .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
  - .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
  - .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
  - .10 Group piping wherever possible.
  - .11 Ream pipes, remove scale and other foreign material before assembly.
  - .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
  - .13 Valves:
    - .1 Install in accessible locations.
    - .2 Remove interior parts before soldering.
    - .3 Install with stems above horizontal position unless indicated.
    - .4 Valves accessible for maintenance without removing adjacent piping.
    - .5 Use gate, ball valves at branch take-offs for isolating purposes except where specified otherwise.
  - .14 Check Valves:
    - .1 Install silent check valves on discharge of pumps and in vertical pipes with upward flow and as indicated.

### **3.8 SLEEVES**

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
  - .2 Other floors: terminate 25 mm above finished floor.
  - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

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- .2 Elsewhere:
    - .1 Provide space for fire stopping.
    - .2 Maintain fire rating integrity.
  - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### **3.9 ESCUTCHEONS**

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: one piece type with set screws.
  - .1 Chrome or nickel plated brass or type 302 stainless steel..
- .3 Sizes: outside diameter to cover opening or sleeve.
  - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

### **3.10 PREPARATION FOR FIRE STOPPING**

- .1 Install fire stopping within annular space between pipes, ducts, insulation and adjacent fire separation.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fire stopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

### **3.11 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Chemical clean piping system in accordance with Section 23 05 06, Mechanical Pipe Cleaning.

### **3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Consultant 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work. All new section of piping and all installations in the mechanical rooms shall be pressure tested at 700Kpa,(105 psi) .
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Consultant.
- .6 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Consultant.

**3.13            EXISTING SYSTEMS**

- .1      Connect into existing piping systems at times approved by Consultant.
- .2      Request written approval by Consultant 10 days minimum, prior to commencement of work.
- .3      Be responsible for damage to existing plant by this work.

**3.14            CLEANING**

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

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1 Section Includes:
  - .1 Electrical motors, drives and guards for mechanical equipment and systems.
  - .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
  - .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

**1.2                REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)

**1.3                SUBMITTALS**

- .1 Product Data:
  - .1 Submit shop[ drawings, specifications and datasheet in accordance with Section 21 05 01 – Mechanical General Requirements Include product characteristics, performance criteria, and limitations.
  - .2 Instructions: submit manufacturer's installation instructions.
- .2 Closeout Submittals
  - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 21 05 01 – Mechanical General Requirements

**Part 2            Products**

**2.1                GENERAL**

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

**2.2                MOTORS**

- .1 Provide motors for mechanical equipment as specified.

- .2 Motors under 373 W 1/2 HP : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W 1/2 HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 208 V, unless otherwise indicated.

### **2.3 BELT DRIVES**

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW 10 HP : standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 Correct size of sheave determined during commissioning.
- .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .6 Motor slide rail adjustment plates to allow for centre line adjustment.
- .7 Supply one set of spare belts for each set.

## **Part 3 Execution**

### **3.1 INSTALLATION**

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

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Materials and installation for thermometers and pressure gauges in piping systems.

**1.2                REFERENCES**

- .1            American Society of Mechanical Engineers (ASME).
  - .1            ASME B40.100-01, Pressure Gauges and Gauge Attachments.
  - .2            ASME B40.200-01, Thermometers, Direct Reading and Remote Reading.
- .2            Canadian General Standards Board (CGSB).
  - .1            CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
  - .2            CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

**1.3                SUBMITTALS**

- .1            Submittals in accordance with Section 21 05 01 – Mechanical General Requirements.
- .2            Submit shop drawings and product data.
- .3            Submit manufacturer's product data for following items:
  - .1            Thermometers.
  - .2            Pressure gauges.
  - .3            Stop cocks.
  - .4            Syphons.
  - .5            Wells.

**Part 2            Products**

**2.1                GENERAL**

- .1            Design point to be at mid point of scale or range.
- .2            Ranges: as indicated.

**2.2                DIRECT READING THERMOMETERS**

- .1            Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB14.4 ASME B40.200.

**2.3 THERMOMETER WELLS**

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.

**2.4 PRESSURE GAUGES**

- .1 Industrial, oil filled, 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
  - .1 Snubber for pulsating operation.
  - .2 Diaphragm assembly for corrosive service.
  - .3 Gasketed pressure relief back with solid front.
  - .4 Bronze stop cock.
  - .5 Oil filled for high vibration applications including: pumps & chillers

**Part 3 Execution****3.1 GENERAL**

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

**3.2 THERMOMETERS**

- .1 Install in wells on piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
  - .1 Domestic Hot water tank inlet and outlet piping
  - .2 Domestic cold water make-up piping
- .3 Use extensions where thermometers are installed through insulation.

**3.3 PRESSURE GAUGES**

- .1 Install in following locations:
  - .1 Domestic water make-up piping.
  - .2 Domestic hot water heater outlet.
  - .3 In other locations as indicated on drawings.
- .2 Install pressure gauge test cocks and single pressure gauge for each equipment differential.
- .3 Install gauge cocks for balancing purposes, elsewhere as indicated.

- .4 Use extensions where pressure gauges are installed through insulation.

**3.4 NAMEPLATES**

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

**END OF SECTION**

**Part 1        General**

**1.1            REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B31.1-07, Power Piping.
- .2 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .3 Underwriter's Laboratories of Canada (ULC)

**Part 2        Products**

**2.1            SYSTEM DESCRIPTION**

- .1 Design Requirements:
  - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
  - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS 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. Amount of adjustment in accordance with MSS SP58.
- .2 Performance Requirements:
  - .1 Design supports, platforms, catwalks, hangers to withstand seismic events as specified.

**2.2            GENERAL**

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

## 2.3 PIPE HANGERS

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.
  - .2 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed 13 mm FM approved.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed [FM approved to MSS SP69.
- .5 Shop and field-fabricated assemblies:
  - .1 Trapeze hanger assemblies:
  - .2 Steel brackets: Sway braces for seismic restraint systems:
- .6 Hanger rods: threaded rod material to MSS SP58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
  - .3 Do not use 22 mm rod.
- .7 Pipe attachments: material to MSS SP58:
  - .1 Attachments for steel piping: carbon steel black.....
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for hot pipework.
  - .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP69 UL listed FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

- .1 Finishes for steel pipework: black.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

**Part 3 Execution****3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems as indicated.
- .3 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt-tightening torques to industry standards.
  - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
  - .1 Vertical movement of pipework is 13 mm or more,
  - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
  - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
  - .2 Variation in supporting effect does not exceed 25 % of total load.

**3.3 HANGER SPACING**

- .1 Plumbing piping: to BC Plumbing Code authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Propane Gas piping: up to NPS 1/2: every 1.8 m.

- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m

### 3.4 HANGER INSTALLATION

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

### 3.5 HORIZONTAL MOVEMENT

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

### 3.6 FINAL ADJUSTMENT

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

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

.1            Section Includes:

- .1            Seismic restraint systems for statically supported and vibration isolated equipment and systems including boilers.
- .2            Applies to the installation of the new heat pumps, fans, unit heaters, radiant heaters and domestic hot water tank.

**1.2                GENERAL**

- .1            Provide Letter of Assurance from a Professional Engineer registered in the province of BC for the seismic securement of the new equipment.
- .2            Seismic securement of equipment and Letters of Assurance shall be paid for by the Mechanical Contractor.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

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

**1.2                REFERENCES**

- .1 Canadian Gas Association (CGA)
  - .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.

**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 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                SYSTEM NAMEPLATES**

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

Size #	mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1		10 x 50	1	3

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

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

.4 Locations:

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

.5 Identification for Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

## **2.3 EXISTING IDENTIFICATION SYSTEMS**

.1 Apply existing identification system to new work.

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

.3 Before starting work, obtain written approval of identification system from Consultant.

## **2.4 PIPING SYSTEMS GOVERNED BY CODES**

.1 Identification:

.1 ANSI A.31

## **2.5 IDENTIFICATION OF PIPING SYSTEMS**

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

.2 Legend:

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

.3 Arrows showing direction of flow:

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

- .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
- .3 Use double-headed arrows where flow is reversible.
- .4 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
- .5 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 Other pipes: pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .6 Colours and Legends:
  - .1 Where not listed, obtain direction from Consultant.
  - .2 Colours for legends, arrows: to following table:
 

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE
  - .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
condensate water	Yellow	CONDENSATE
hot water supply	Green	HW SUPPLY
Hot water return	Green	HW RETURN
Domestic cold water supply	Green	DOM. CWS

**2.6 IDENTIFICATION DUCTWORK SYSTEMS**

- .1 Identify ductwork in the mechanical room with 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

**2.7 VALVES, CONTROLLERS**

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

**2.8 CONTROLS COMPONENTS IDENTIFICATION**

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

**2.9 LANGUAGE**

- .1 Identification in English.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC or CSA registration plates as required by respective agency.

**3.3 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.

**3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS**

- .1 On long straight runs in open areas and in mechanical equipment rooms at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At beginning and end points of each run and at each piece of equipment in run.
- .4 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .5 Identification easily and accurately readable from usual operating areas and from access points.

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

### **3.5 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 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.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1    TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC systems.
- .2    TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

**1.2                SCOPE OF WORK**

- .1    Air Balancing
  - .1    Outdoor Air intake into each of the two heat pump units, HPI-1 & HPI-2.
  - .2    Exhaust fan EF-101.
  - .3    Relief air opening at full outdoor air conditions.
  - .4    Minimum ventilation air for the two new heat pumps.
  - .5    Return air into each of the two heat pumps.
  - .6    All supply return and exhaust air terminals served by the two heat pumps and exhaust fan EF-101.

**1.3                QUALIFICATIONS OF TAB PERSONNEL**

- .1    Submit names of personnel to perform TAB to Consultant within 30 days of award of contract.
- .2    Provide documentation confirming qualifications, successful experience.
- .3    TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
  - .1    Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
  - .2    National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998  
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4    Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5    Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .6    TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
  - .1    For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

**1.4 PURPOSE OF TAB**

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.
- .4 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

**1.5 CO-ORDINATION**

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

**1.6 PRE-TAB REVIEW**

- .1 Review contract documents before project construction is started and confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Consultant in writing proposed procedures which vary from standard.

**1.7 START-UP**

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

**1.8 START OF TAB**

- .1 Notify Consultant 7 days prior to start of TAB.
- .2 Start TAB when installation of the equipment is essentially completed, including:
  - .1 Air handling equipment installed and started up.
  - .2 Heat pumps and propane fired heaters installed and started up.
  - .3 Piping connections including pipe testing and cleaning.
  - .4 Filters in place and clean.
  - .5 Duct systems clean, access doors installed and closed, air terminals installed and balance dampers fully open.
  - .6 Provisions for TAB installed and operational.

- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Air systems:
    - .1 Furnaces installed, vented and fully operational.
    - .2 Heat pumps installed and fully operational.
    - .3 Filters in place, clean.
    - .4 Air balancing devices installed and open.

### **1.9 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 Air supply and return systems: plus or minus 10%.

### **1.10 INSTRUMENTS**

- .1 Prior to TAB, submit to Consultant list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 6 months of TAB. Provide certificate of calibration to Consultant.

### **1.11 ACCURACY TOLERANCES**

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

### **1.12 TAB REPORT**

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit 1 electronic copy of TAB Report to Consultant for verification and approval, in English.

### **1.13 VERIFICATION**

- .1 Reported results subject to verification by Consultant.
- .2 Pay costs to repeat TAB as required to satisfaction of Consultant.

### **1.14 COMPLETION OF TAB**

- .1 TAB considered complete when final TAB Report received and approved by Consultant.

### **1.15 OTHER TAB REQUIREMENTS**

- .1 Air systems balancing
  - .1 Minimum outdoor air flow rates for the two heat pumps.
  - .2 Utilize fan curve and differential pressure compared to manufacturer's data sheets.
  - .3 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
  - .4 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb and relative humidity), duct cross sectional area, RPM, electrical power, voltage, current, noise, vibration.
  - .5 Contractor to submit air TAB report to the Consultant.

**Part 2 PRODUCTS**

**2.1 NOT USED**

- .1 Not used.

**Part 3 EXECUTION**

**3.1 NOT USED**

- .1 Not used.

END OF SECTION

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**Part 1            General**

**1.1            GENERAL**

- .1        The following equipment schedules are to be read in conjunction with the pertinent sections of the specification. The specification sections and the schedules are complimentary to one another.
- .2        The equipment make and size shown in the schedules is that which the project design and drawings are based on and for which space in the building design has been allocated.
- .3        Manufacturers name and model number are provided to establish the quality and arrangement of the equipment. Where alternative equipment makes have been shown in the specification equipment sections, the Mechanical Approval List, or are approved during the tender process, it shall be the contractors and equipment suppliers responsibility to assure that the alternate equipment meets all the requirements of the specification, is of adequate size and capacity, has similar electrical characteristics, is suitable for the duty intended, and is of a physical size and shape to fit into the space which has been allocated in the system design. Where any alternate equipment fails to meet any of the criteria for the use of alternate equipment spelled out in this specification, it shall be rejected for use in the project.

**1.2            INDEX**

- .1        Heat Pump Outdoor Condensing Units – HPO - 1 and HPO - 2.
- .2        Split System Heat Pump Indoor Fan Coil; HPI – 1 and HPI - 2.
- .3        In Line Exhasust Fan; EF - 101.
- .4        Air Terminals.
- .5        Intake air Louvre.
- .6        Control Dampers, CD-1a, 1b and 1c.
- .7        Control dampers CD-2a, and 2b.

**Part 2            Equipment**

**2.1                HEAT PUMP CONDENSING UNIT – OUTDOOR AIR SOURCE**

<b>Tag</b>	<b>Units</b>	<b>HPO-1</b>	<b>HPO-2</b>
Service	-	CC-1	CC-2
Location	-	Outdoors	Outdoors
Type	-	Air Source Heat Pump	Air Source Heat Pump
Nominal Tonnage	<i>Tons Cooling</i>	5	5
Independent Refrigerant Circuits	<i>qty</i>	1	1
Maximum Cooling Ambient Dry Bulb Temp.	<i>°C (°F)</i>	35° (95°)	35° (95°)
Cooling Capacity @ 27°C	<i>kW (BTU/H)</i>	16.2 (55.5)	16.2 (55.5)
Heating Capacity @ +8°C	<i>kW (BTU/H)</i>	17.0 (58.0)	17.0 (58.0)
SEER	-	16.0	16.0
COP Heating	-	4.06	4.06
Airflow	<i>l/s (cfm)</i>	1795 (3800)	1700 ( 3600)
Fan Motor	<i>kW (HP)</i>	.19 (1/4)	.19 (1/4)
Electrical	<i>V/PH/Hz</i>	208/1/60	208/1/60
Overcurrent Protection Min/Max	<i>Amps.</i>	40/60	40/60
Minimum Circuit Ampacity	<i>Amps</i>	33.8	33.8
Refrigerant	-	R410a	R410a
Dimensions; W x D x H	<i>cm</i>	86 x 107 x 101	86 x 107 x 101
Standard of Acceptance: Manufacturer	-	York	York
Standard of Acceptance: Model Number	-	YZF060 MV20D	YZF060 MV20D
Notes		1, 2, 3	1, 2, 3

.1            Notes for Heat Pump Condensing Units:

- .1            TXV Valve Kit S1-1TVM Series.
- .2            Two stage cooling control.
- .3            BACnet interface for communications with DDC controls system.

**2.2 HEAT PUMP FAN COIL UNIT – INDOORS**

Tag	Units	HPI-1	HPI-2
Service	-	HPO-1	HPO-2
Location	-	In Lab Area Tight to U/S of Ceiling	In Lab Area Tight to U/S of Ceiling
Type	-	Air Source, split system Heat Pump Fan Coil	Air Source, split system Heat Pump Fan Coil
Nominal Tonnage	<i>Tons Cooling</i>	5.0	5.0
Independent Refrigerant Circuits	<i>qty</i>	1	1
Entering Air Db/Wb Temp.	<i>°C (°F)</i>	26/18° (80/67°)	26/18° (80/67°)
Cooling Capacity	<i>kW (BTU/H)</i>	16.2 (55.5)	16.2 (55.5)
Heating Capacity @ +8°C OA	<i>kW (BTU/H)</i>	17.0 (58.0)	17.0 (58.0)
Airflow	<i>l/s (cfm)</i>	940 (2000)	940 (2000)
Fan Motor	<i>kW (HP)</i>	.56 (3/4)	.56 (3/4)
Electrical	<i>V/PH/Hz</i>	208/1/60	208/1/60
Overcurrent Protection Min/Max	<i>Amps.</i>	35/40	35/40
Minimum Circuit Ampacity/Wire size	<i>Amps/ AWG</i>	39/8	39/8
Refrigerant	-	R410a	R410a
Dimensions; W x L x H	<i>cm</i>	55 x 144 x 44	55 x 144 x 44
Arrangement	-	Horizontal Right	Horizontal Left
Standard Of Acceptance: Manufacturer	-	York	York
Standard Of Acceptance: Model Number	-	AHE60D	AHE60D
Notes		1	1

.1 Notes:

.1 Site Glass, 25 x 400 x 500 Merv 8 Filter and TXV Valve Kit S1-1TVM Series.

**2.3 FANS – EXHAUST**

<b>UNIT NO.</b>	<b>Units</b>	<b>EF-101</b>
Service	-	General Exhaust
Location	-	Lab Room
Fan Type	-	In Line
Air Flow	<i>l/s (cfm)</i>	200 (420)
Fan S.P.	<i>Pa (in)</i>	60 (0..25")
Fan Draw	<i>W</i>	248
Fan 1140	<i>RPM</i>	2849
Inlet/Outlet Size	<i>cm (inches)</i>	100/100 (4"/4")
Drive Type	-	Direct
Volts/Phase/Hz	-	120/1/60
Standard Of Acceptance: Manufacturer	-	FanTech
Standard Of Acceptance: Model No.	-	FR250
Notes		1

.1 Notes:

- .1 Complete with disconnect switch, manual speed controller and RSK4 backdraft damper installed on the inlet to the fan.

**2.4 CONTROL DAMPERS – MODULATING**

<b>Tag</b>	<b>Units</b>	<b>CD-1a &amp; 2a</b>	<b>CD – 1b &amp; 2b</b>	<b>CD-3a</b>
Service	-	Outdoor Air for Heat Pumps 1 & 2	Return Air for Heat Pumps 1 & 2	Relief Air for Heat Pumps 1 & 2
Location	-	Lab Room	Lab Room	Lab Room
Type	-	Steel, Low Leakage Damper	Steel, Low Leakage Damper	Steel, Low Leakage Damper
Arrangement	-	Horizontal	Horizontal	Horizontal
Airflow	<i>l/s (cfm)</i>	940 (2,000)	970 (1,500)	470 (1,000)
Size (inside Clear)	<i>cm (inches)</i>	45 x 45 (18" x 18")	45 x 45 (18" x 18")	60 x 40 (24" x 16")
Face Velocity	<i>m/s (fpm)</i>	4.5 (890)	3.4 (667)	2.3 (445)
Max Pressure Drop	<i>Pa (in WC)</i>	25 (.1)	25 (.1)	25 (.1)
Standard Of Acceptance: Manufacturer	-	West Vent	West Vent	West Vent
Standard Of Acceptance: Model #	-	AFS – 6C6	AFS – 6C6	AFS – 6C6
Weight	<i>Kg (lbs)</i>	10 (22)	10 (22)	10 (22)
Notes		1	1	1

.1 Notes:

- .1 Complete with modulating, spring return damper actuator.

2.5 AIR TERMINALS & GRILLES

<b>Tag</b>	<b>Units</b>	<b>SR-1</b>	<b>RG-1</b>	<b>DG-1</b>
Service	-	Supply Air	Return/Exhaust	Door Grille
Location	-	Refer to Drwgs	Refer to Drwgs	Refer to Drwgs
Type	-	Louvred Face	Egg Crate Grille	Air Transfer Grille
Size	<i>cm (inches)</i>	Refer to Drwgs	Refer to Drwgs	Refer to Drwgs
Air Flow	<i>kW (MBH)</i>	Refer to Drwgs	Refer to Drwgs	Refer to Drwgs
Material	-	Aluminum	Aluminum	Steel
Core Type	-	Double Deflection	12 x 12 cm Grid	Sightproof
Standard Of Acceptance: Manufacturer	-	E H Price	E H Price	E H Price
Standard Of Acceptance: Model #	-	22	Core 80	ATGH
Burner Box Weight	Kg (lbs)	15 (35)	15 (35)	15 (35)
Notes		1	1	2

.1 Notes:

- .1 Complete with border and mounting frame suitable for surface or exposed duct mounting to suit, and B12 white powder coat finish.
- .2 Complete with BF flat border on both sides and B15 Aluminum Powder coat.

END OF SECTION

**Part 1            General**

**1.1                REQUIREMENTS**

- .1     The following listed manufacturers are meant to provide an example of products that are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed manufacturers/suppliers. **Alternate manufactures which meet the technical and performance requirements of the specifications may apply for approval as an acceptable manufacture.**
- .2     It remains the responsibility of the contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.
- .3     The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers list.
- .4     Submit within 14 days of contract award a copy of the list underlining the name of the manufacturer whose price was carried in the tender. If no manufacturers' names are submitted, it will be assumed that the price carried in the tender was that of the specified manufacturer or where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.
- .5     Submit shop drawings on all items marked with an asterisk (\*) within 30 days of award of contract.

**Part 2            Products**

**2.1                EQUIPMENT & ACCESSORIES**

EQUIPMENT/ACCESSORIES	SUPPLIERS / MANUFACTURERS (APPROVED EQUALS)
<b>ACCESS DOORS / PANELS</b>	
Building Surfaces	Acudor, Cendrex, E.H. Price, Maxam, Milcor, Mifab, Steel Brothers
Ducts	Nailor, Ventlok
<b>AIR CONDITIONERS/HEAT PUMPS</b>	
Heat Pumps	York, Carrier, Eng. Air, Lennox, Trane, McQuay

<b>EQUIPMENT/ACCESSORIES</b>	<b>SUPPLIERS / MANUFACTURERS (APPROVED EQUALS)</b>
<b>FANS</b>	
Supply Fans	Fantech, ACME, Nutone, EH Price
<b>DUCT CONNECTORS FLEXIBLE</b>	Duro Dyne "Durolon", Ventfabrics - "Ventlon", Dynair Hypalon
<b>FIRE STOPPING</b>	Hilti Canada Ph. 1-800-363-4458 Nexlevel Construction Solutions, Jim Smiley Ph. 1-647-288-1326 JV Firestop Inc. Ph. 1-416-356-7102 Fire Stop Systems Ph. 1-647-288-1326
<b>DUCTWORK FLEXIBLE</b>	
Plain	Thermaflex SLP10, Flexmaster FAB4, Wiremold 57
Insulated – Acoustic	Thermaflex MKE, Glassflex ABL-181, Wiremold WK
Insulated - Thermal	Thermaflex MKC, Micro-Aire JFLX SL, Glassflex D-181, Wiremold WGC
<b>FILTERS</b>	AAF, Cambridge, Camfil Farr
<b>INSULATION - DUCT</b>	Fiberglas, Knauf, Johns-Manville, Atlas, PPG, Manson, Certainteed
<b>INSULATION - PIPING</b>	Fiberglas, Knauf, Johns-Manville, Manson, Atlas, PPG, Certainteed
<b>AIRTERMINALS</b>	EH Price, Titus, Westvent
<b>VALVES</b>	
<b>Valves - Gate, Globe, Swing, Check, Ball</b>	Jenkins, Toyo, Crane, Kitz, Milwaukee, KVC
Valves - Gate, Globe, Swing, Check, Ball	Jenkins, Toyo, Crane, Kitz, Milwaukee, KVC

**Part 3            Execution**

**3.1                NOT USED**

**END OF SECTION**

Subcontractors include, but are not limited to, controls contractors, commissioning agents and air and water balancing agencies.

Subcontractors shall be experienced in the work to be undertaken and shall be able to demonstrate competency in the area of specialization. References are to be provided if requested by the Engineer.

Subcontractors must have a valid, Provincial Red Seal Certification or other equivalent certification. Subcontractors shall provide a copy of this Certification during the shop drawing submission process.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED DOCUMENTS**

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- .2 Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

**1.2                SUMMARY**

- .1 Perform all Work required to provide and install ductwork insulation and jackets indicated by the Contract Documents with supplementary items necessary for proper installation.

**1.3                REFERENCE STANDARDS**

- .1 The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- .2 All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project
- .3 All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references.
  - .1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
  - .2 ASTM C168 - Terminology Relating to Thermal Insulation Materials.
  - .3 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - .4 ASTM C553 - Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .5 ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
  - .6 ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - .7 ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
  - .8 ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
  - .9 ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
  - .10 ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
  - .11 ASTM E84 - Surface Burning Characteristics of Building Materials.
  - .12 ASTM E96 - Water Vapor Transmission of Materials.

- .13 ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- .14 ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .15 NFPA 255 - Surface Burning Characteristics of Building Materials.
- .16 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .17 UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- .18 UL 723 - Surface Burning Characteristics of Building Materials.
- .19 ASTM E2336 - Standard for Grease Ducts.
- .20 ASTM D5590 - - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay

#### **1.4 QUALITY ASSURANCE**

- .1 All ductwork requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.
- .2 All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this Section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.
- .3 Application Company Qualifications: Company performing the Work of this Section must have minimum three (3) years' experience specializing in the trade.
- .4 All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.
- .5 All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable.

#### **1.5 SUBMITTALS**

- .1 Product Data
  - .1 Provide product description, list of materials, "k" value, "R" value, mean temperature range, and thickness for each service and location
- .2 Record Documents
  - .1 Submit under provisions of Division 01

- .3 Operation and Maintenance Data
  - .1 Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.
  - .2 Manufacturer's Installation Instructions: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

**1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store, protect, and handle products to the Project Site under provisions of Division 01 and Division 20.
- .2 Deliver materials to Site in original factory packaging, labeled with manufacturer's identification including product thermal ratings and thickness.
- .3 Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.
- .4 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements,

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**Part 2            Products**

**2.1                GENERAL**

- .1        All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

**2.2                MANUFACTURERS**

- .1        CertainTeed Corporation.
- .2        Johns Manville Corporation.
- .3        Knauf Corporation.
- .4        Owens-Corning.
- .5        Armacell North America.
- .6        Unifrax 1 LLC. (FyreWrap)
- .7        3M Fire Protection Products (Fire Barrier Duct Wrap 615+)

**2.3                INSULATION MATERIALS**

- .1        Type D1: Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.
- .2        Type D2: Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.
- .3        Type D3: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable acrylic surface coating specifically formulated to:
  - .1        Be no more corrosive than sterile cotton when tested in accordance with the test method for corrosiveness in ASTM C665.
  - .2        Absorb no more than 3 percent by weight when tested in accordance with the test method for moisture vapor sorption in ASTM C1104.
  - .3        Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM C1071, ASTM C1338, ASTM G21, and ASTM G22.
  - .4        Show no signs of warpage, cracking, delaminating, flaming, smoking, glowing, or any other visibly negative changes when tested in accordance with the test method for temperature resistance in ASTM C411.
  - .5        Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.

- .6 Meet the sound absorption requirements when tested in accordance with the test method for sound absorption in ASTM C423.
- .7 Show no evidence of continued erosion, cracking, flaking, peeling, or delamination when tested in accordance with the test method for erosion resistance in UL181.
- .4 Type D4: Fire Rated Grease Duct Insulation (High Temperature Flexible Blanket); 1-1/2-inch thick refractory grade fibrous fire barrier material with minimum service temperature design of 2,000 degrees F; aluminum foil laminated on both sides; with a minimum 'k' value of 0.25 and a minimum density of 6 lbs/cu ft; containing no asbestos. Listed by a nationally recognized testing laboratory (NRTL) UL to meet ASTM E 2336, ASTM E119, and with flame spread/smoke minimum rating of 25 / 50 when tested as per ASTM E84/UL 723.
- .5 Type D5: Outdoor Duct Insulation (Closed Cell Flexible Elastomeric Insulation); 1 inch thick material that has a service temperature range from -60 degrees F to 180 degrees F. This outdoor duct insulation meets ASTM C 177 or C 518 and shall have minimum 'k' value of 0.27 Btu-in. / hr-ft<sup>2</sup>- degrees F at minimum density measurement of 3 lb/cu ft. The insulation and outside surface must be protected with a white Thermo Plastic Rubber Membrane formulated to:
  - .1 Be resistant to UV, and ozone, acid rain, and physical elements produced from outdoor weather per ASTM E 96 Procedure A.
  - .2 Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
  - .3 Show no evidence of continued erosion, delaminating, cracking, flaking, or peeling when tested in accordance with the test method for erosion resistance in UL181. Be resistant to mold growth resistance, ASTM G 21/C 1338 resistant to fungi, and resistant to bacteria growth per ASTM G 22.
  - .4 Type D6: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable polyacrylate copolymer emulsion specifically formulated to:
    - .1 Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM D 5590 with "0" growth rating.
    - .2 Act as a fungicidal protective coating: water based, VOC < 50 g/l. Fungicidal coating must be EPA registered for use in HVAC duct systems. Manufacturer: H.B. Fuller Construction Products Inc., Foster 40-20 (white) or 40-30 (black) Fungicidal Protective Coating or approved equal. Coatings may also be used to repair damage to duct liner insulation.

## **2.4 INSULATION ACCESSORIES**

- .1 Adhesives: Waterproof vapor barrier type, meeting requirements of ASTM C916; Childers CP-82 or Foster 85-20.
- .2 Weather Barrier: Breather Mastic:, Childers CP-10/CP-11 or Foster 46-50 White..
- .3 Vapor Barrier Coating: Permeance - ASTM E 96, Procedure B, 0.08 perm or less at 45-mil dry film thickness, tested at 100F and 50%RH; Foster 30-65 or Childers CP-34
  - .1 When higher humidity levels may be of concern, only specify the following fungus/mold resistant coating: Foster 30-80 AF (anti fungal). Coating must meet ASTM D 5590 with 0 growth rating\*\*
- .4 Reinforcing Mesh: 10x10 or 9x8 glass mesh; Foster Mast a Fab or Childers #10
- .5 Jacket: Pre-sized glass cloth, minimum 7.8 oz/sq yd.
- .6 Type D4 Insulation Adhesive: Fire resistive to ASTM E84, Childers CP-82 or Foster 85-20.
- .7 Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- .8 Joint Tape: Glass fiber cloth, open mesh.
- .9 Tie Wire and Wire Mesh: Annealed steel, 16 gage.
- .10 Stainless Steel Banding: 3/4-inch wide, minimum 22 gage, 304 stainless.
- .11 Armaflex 520, 520 BLV, or Foster 85-75 contact adhesive.
- .12 Armatuff 25 white seal seam tape.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Verify that ductwork has been tested before applying insulation materials.
- .2 Verify that surfaces are clean, foreign material removed, and dry.
- .3 Maintain required ambient temperature during and after installation for a minimum period of 24 hours.

### **3.2 INSTALLATION**

- .1 Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- .2 All installation shall be in accordance with manufacturer's published recommendations.
- .3 Extend duct insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated.
- .4 Provide external insulation on all round ductwork connectors to ceiling diffusers and on top of diffusers as indicated in the Ductwork Insulation Application and Thickness Schedule and the Drawings. Secure insulation to the top of ceiling diffusers with adhesive

that meets NFPA 90A and 90B 25/50 requirements, and vapor barrier or tape to match jacket. Do not insulate top of ceiling diffuser if it is used in ceiling return air plenum or in an open space with no ceiling.

- .5 Flexible and Rigid fiberglass insulation (Types D1 and D2) application for exterior of duct:
  - .1 Secure insulation jacket joints with vapor barrier adhesive or tape to match jacket.
  - .2 Install without sag on underside of ductwork. Use 4-inch wide strips of adhesive on 8-inch centers and mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
  - .3 Insulate standing seams and stiffeners that protrude through the insulation with 1-1/2 inch thick, unfaced, flexible blanket insulation. Cover with reinforcing mesh and coat with vapor barrier finish coating.
  - .4 On circumferential joints, the 2-inch flange on the facing shall be secured with 9/16 inch outward clinch steel staples on 2-inch centers, and taped with minimum 3-inch wide strip of glass fabric and finish coating.
  - .5 Vapor seal all seams, joints, pin penetrations and other breaks with vapor barrier coating reinforced with reinforcing mesh.
- .6 Duct Liner (Type D3 or D6) application for interior of return air sound boots and where acoustic insulation is indicated on drawings:
  - .1 Secure insulation with 100 percent coverage of duct liner adhesive, pins and clips not more than 18 inches on center.
  - .2 Secure bottom of duct insulation using alternate single and double clips. The first pin will secure the insulation and the second clip will be used to secure the cladding. Isolate the exterior clip from the cladding by using two 1/8 inch closed cell neoprene (Armaflex) washers on either side of the cladding. Predrill holes in cladding and avoid contact with pin during installation.
  - .3 For round duct, secure insulation with 100 percent coverage of duct liner adhesive. Secure cladding with 3/4 inch, 0.020 inch stainless steel bands on 12-inch centers.
  - .4 For joints and overlaps, fold cladding to form a double thickness hem 2 inches minimum. Seal with a non-shrink, non-hardening sealing compound.
  - .5 Type D6: Provide fungicidal coating in air handlers ten feet on either side, first ten feet downstream of cooling coils, ten feet downstream of mix boxes, in mechanical rooms or as otherwise specified in potentially high humidity areas in the duct system shall be coated with an fungicidal coating; EPA registered for use in HVAC duct systems at a coverage rate of 80 ft<sup>2</sup>/gallon.
- .7 Insulation (Type D5) application for outdoor ducts
  - .1 Horizontal ductwork located outdoors shall be sloped at a minimum 2-degree angle to prevent the accumulation of water on top of the finished insulated duct. Support members that connect directly to the ductwork are to be insulated with

this same material. Keep compression or sharp creases of outdoor insulation to a minimum by distributing the weight of the duct resting on horizontal duct support members.

- .2 Follow the insulation manufacturer’s installation instructions and procedures to assure the ductwork is properly insulated and that the insulation will meet the manufacturer’s warranty requirements.
- .8 All ductwork, accessories, and all plenums including metal and masonry construction, etc., shall be insulated as indicated on the Drawings, as specified herein and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
- .9 Flexible ductwork connections to equipment shall not be insulated.
- .10 Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
- .11 Extreme care shall be taken in insulating high and medium pressure ductwork including all ductwork between the fan discharge and all mixing boxes to ensure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these Specifications are classified as high velocity ductwork.
- .12 Where canvas finish is specified use lagging adhesive/coating to prevent mildew in securing canvas. Do not use wheat paste. Use only anti fungal lagging adhesive that adheres to ASTM D 5590 with 0 growth rating. (Foster 30-60, Childers CP-137AF). In addition, cover all exterior canvas-covered insulation with a fire retardant weather barrier mastic.
- .13 All supply ductwork in the Project shall be insulated; all exhaust and fume hood exhaust ductwork shall not be insulated, unless used for energy recovery purposes or noted on drawings.
- .14 Flexible round ducts shall be factory insulated.

**3.3 INSPECTION**

- .1 Visually inspect the completed insulation installation per manufacturers recommended materials, procedures and repair or replace any improperly sealed joints.
- .2 Where there is evidence of vapor barrier failure or “wet” insulation after installation, the damaged insulation shall be removed, duct surface shall be cleaned and dried and new insulation shall be installed

**3.4 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE**

Ductwork System	Application	Insulation Type	Insulation Thickness (mm)
Supply Air (All new ductwork)	Exposed/Outside of Mechanical Rooms	D1	37

<b>Ductwork System</b>	<b>Application</b>	<b>Insulation Type</b>	<b>Insulation Thickness (mm)</b>
	Inside of Mechanical Rooms	D2	37
Return Air, Relief Air, and Exhaust Air	All, except where noted otherwise on drawings	-	0
Outdoor Intake Air,	All	D1 or D3	50
Return Air	Where acoustic insulation noted on drawings	D3	25

**END OF SECTION**

**Part 1      General**

**1.1          SUMMARY**

.1      Section Includes:

- .1      Thermal insulation for new domestic hot and cold water.

**1.2          REFERENCES**

- .1      .
- .2      Canadian General Standards Board (CGSB)
  - .1      CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2      CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .3      Manufacturer's Trade Associations
  - .1      Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .4      Underwriters' Laboratories of Canada (ULC)
  - .1      CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2      CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .3      CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
  - .4      CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

**1.3          DEFINITIONS**

.1      For purposes of this section:

- .1      "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
- .2      "EXPOSED" - will mean "not concealed" as specified.

.2      TIAC ss:

- .1      CRF: Code Rectangular Finish.
- .2      CPF: Code Piping Finish.

**1.4 SUBMITTALS.**

- .1 Samples:
  - .1 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.

**1.5 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 of TIAC.

**Part 2 Products**

**2.1 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC-S102.
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

**2.2 INSULATION**

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

**Part 3 Products**

- .1 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.
  - .3 Jacket: to CGSB 51-GP-52Ma.

- .2 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to CAN/ULC-S702.
- .3 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C553.

### **3.2 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.

### **3.3 CEMENT**

- .1 Thermal insulating and finishing cement:
  - .1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

### **3.4 VAPOUR RETARDER LAP ADHESIVE**

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

### **3.5 INDOOR VAPOUR RETARDER FINISH**

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

### **3.6 OUTDOOR VAPOUR RETARDER FINISH**

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

### 3.7 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: White.
  - .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 Indoor: None
    - .2 Outdoor: UV rated material at least 0.5 mm thick.
- .2 Canvas:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: compatible with insulation.
- .3 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.

**Part 4 Execution**

**4.1 MANUFACTURER'S INSTRUCTIONS**

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

**4.2 PRE-INSTALLATION REQUIREMENT**

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

**4.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

**4.4 PIPING INSULATION SCHEDULES**

- .1 Includes valves, valve bonnets, strainers, flanges and fittings, pump bodies on new piping unless otherwise specified.
- .2 TIAC Code: A-1.
  - .1 Securements: SS wire, bands, tape at 300 mm on centre.
  - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
  - .3 Installation: TIAC Code: 1501-H.
- .3 Thickness of insulation as listed in following table.

Application	Temp °C	TIAC code	Thickness mm
Hot Water piping (All new and replaced piping)	10 - 100	A-1	40

- .4 Finishes:
  - .1 Exposed indoors and in mechanical rooms: canvas
  - .2 Use non vapour retarder jacket on TIAC code A-1
  - .3 Installation: to appropriate TIAC code CRF/1 through CPF/5.
  - .4 Canvas jacket.

#### **4.5 CLEANING**

- .1 Proceed in accordance with Section 23 05 06 – Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1      General**

**1.1          SUMMARY**

.1      Section Includes:

.1      Thermal insulation for new domestic hot and cold water.

**1.2          REFERENCES**

.1      .

.2      Canadian General Standards Board (CGSB)

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

.2      CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for  
Insulated Pipes, Vessels and Round Ducts

.3      Manufacturer's Trade Associations

.1      Thermal Insulation Association of Canada (TIAC): National  
Insulation Standards (Revised 2004).

.4      Underwriters' Laboratories of Canada (ULC)

.1      CAN/ULC-S102-03, Surface Burning Characteristics of Building  
Materials and Assemblies.

.2      CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and  
Pipe Covering.

.3      CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for  
Buildings

.4      CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for  
Buildings, Part 2: Application Guidelines.

**1.3          DEFINITIONS**

.1      For purposes of this section:

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

.2      "EXPOSED" - will mean "not concealed" as specified.

.2      TIAC ss:

.1      CRF: Code Rectangular Finish.

.2      CPF: Code Piping Finish.

**1.4 SUBMITTALS.**

- .1 Samples:
  - .1 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.

**1.5 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 of TIAC.

**Part 2 Products**

**2.1 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC-S102.
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

**2.2 INSULATION**

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

**Part 3 Products**

- .1 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.
  - .3 Jacket: to CGSB 51-GP-52Ma.

- .2 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to CAN/ULC-S702.
- .3 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C553.

### **3.2 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.

### **3.3 CEMENT**

- .1 Thermal insulating and finishing cement:
  - .1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

### **3.4 VAPOUR RETARDER LAP ADHESIVE**

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

### **3.5 INDOOR VAPOUR RETARDER FINISH**

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

### **3.6 OUTDOOR VAPOUR RETARDER FINISH**

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

### 3.7 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: White.
  - .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 Indoor: None
    - .2 Outdoor: UV rated material at least 0.5 mm thick.
- .2 Canvas:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: compatible with insulation.
- .3 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.

**Part 4 Execution**

**4.1 MANUFACTURER'S INSTRUCTIONS**

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

**4.2 PRE-INSTALLATION REQUIREMENT**

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

**4.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

**4.4 PIPING INSULATION SCHEDULES**

- .1 Includes valves, valve bonnets, strainers, flanges and fittings, pump bodies on new piping unless otherwise specified.
- .2 TIAC Code: A-1.
  - .1 Securements: SS wire, bands, tape at 300 mm on centre.
  - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
  - .3 Installation: TIAC Code: 1501-H.
- .3 Thickness of insulation as listed in following table.

Application	Temp °C	TIAC code	Thickness mm
Hot Water piping (All new and replaced piping)	10 - 100	A-1	40

- .4 Finishes:
  - .1 Exposed indoors and in mechanical rooms: canvas
  - .2 Use non vapour retarder jacket on TIAC code A-1
  - .3 Installation: to appropriate TIAC code CRF/1 through CPF/5.
  - .4 Canvas jacket.

#### **4.5 CLEANING**

- .1 Proceed in accordance with Section 23 05 06 – Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1    Section Includes:
  - .1        Procedures and cleaning solutions for cleaning mechanical piping systems.

**1.2                REFERENCES**

- .1    American Society for Testing and Materials International (ASTM)
  - .1        ASTM E202-[00], Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2    Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1        Material Safety Data Sheets (MSDS).

**1.3                SUBMITTALS**

- .1    Product Data:
  - .1        Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.

**1.4                QUALITY ASSURANCE**

- .1    Health and Safety:
  - .1        Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

**1.5                DELIVERY, STORAGE, AND HANDLING**

- .1    Packing, shipping, handling and unloading:
  - .1        Deliver, store and handle in accordance with manufacturer's written instructions.
- .2    Waste Management and Disposal:
  - .1        Construction/Demolition Waste Management and Disposal: separate waste materials for [reuse] [and] [recycling] [\_\_\_\_] in accordance with Section [01 74 19 - Construction/Demolition Waste Management and Disposal] [\_\_\_\_].

**Part 2            Products**

**2.1                CLEANING SOLUTIONS**

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

**Part 3 Execution****3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 CLEANING HYDRONIC SYSTEMS**

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
  - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
  - .1 Provide detailed report outlining proposed cleaning procedures at least 2 weeks prior to proposed starting date. Report to include:
    - .1 Cleaning procedures, flow rates, elapsed time.
    - .2 Chemicals and concentrations used.
    - .3 Inhibitors and concentrations.
    - .4 Specific requirements for completion of work.
    - .5 Special precautions for protecting piping system materials and components.
    - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
  - .1 Systems: free from construction debris, dirt and other foreign material.
  - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
  - .3 Strainers: clean prior to initial fill.
  - .4 Install temporary filters on pumps not equipped with permanent filters.
  - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
  - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
  - .1 Fill system with water, ensure air is vented from system.
  - .2 Use water metre to record volume of water in system to +/- 0.5%.

- .3 Add chemicals under direct supervision of chemical treatment supplier.
- .4 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
- .5 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
- .6 Add chemical solution to system.
- .7 Establish circulation, raise temperature slowly to [maximum design] [82 degrees C minimum]. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

### **3.3 START-UP OF HYDRONIC SYSTEMS**

- .1 After cleaning is completed and system is filled:
  - .1 Establish circulation and expansion tank level, set pressure controls.
  - .2 Ensure air is removed.
  - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
  - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
  - .5 Clean out strainers repeatedly until system is clean.
  - .6 Commission water treatment systems.
  - .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
  - .8 Repeat with water at design temperature.
  - .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
  - .10 Bring system up to design temperature and pressure slowly.
  - .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .12 Adjust pipe supports, hangers, springs as necessary.
  - .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
  - .14 Check operation of drain valves.
  - .15 Adjust valve stem packings as systems settle down.
  - .16 Fully open balancing valves (except those that are factory-set).
  - .17 Check operation of over-temperature protection devices on circulating pumps.

### **3.4 FIELD QUALITY CONTROL**

- .1 Verification requirements, include:
  - .1 Materials and resources.

- .2 Storage and collection of recyclables.
- .3 Construction waste management.
- .4 Resource reuse.
- .5 Recycled content.
- .6 Local/regional materials.
- .7 Low-emitting materials.

**3.5 CLEANING**

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

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for copper tubing and fittings for refrigerant between the indoor heat pumps, HPI-1 and HPI-2 and the outdoor heat pumps; HPO-1 & HPO-2.
  - .2 Insulation of the refrigerant suction line piping.
  - .3 All work decommissioning and installing equipment which contains halocarbons shall be done by a certified HVAC Refrigeration Technician. Service logs and leak/pressure test tickets shall be provided and submitted to the Consultant for review.

**1.2                REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.22-[01], Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
  - .2 ASME B16.26-[88], Cast Copper Alloy Fittings for Flared Copper Tubes.
  - .3 ASME B31.5-[01], Refrigeration Piping and Heat Transfer Components.
- .2 American Society for Testing and Materials International (ASTM)
  - .1 ASTM B280-[03], Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 Canadian Standards Association (CSA International)
  - .1 CSA B52-[99], Mechanical Refrigeration Code.

**Part 2            Products**

**2.1                TUBING**

- .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
  - .1 Hard copper: to ASTM B280, type ACR.
  - .2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

**2.2                FITTINGS**

- .1 Service: design pressure 2070 kPa and temperature, 121° C.
- .2 Brazed and/or flared:
  - .1 Fittings: wrought copper to ASME B16.22.
  - .2 Joints: silver solder, 15% Ag-80% Cu-5%P and non-corrosive flux.

- .3 Flared:
  - .1 Bronze or brass, for refrigeration, to ASME B16.26.

### **2.3 PIPE SLEEVES**

- .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

### **2.4 VALVES, FILTER DRYERS, SIGHT GLASS**

- .1 Ball type valves, full port size, 4 Mpa pressure rating, with brass body, brazed connections, suitable with all refrigerants.
- .2 Filter dryer, 3.5 MPa pressure rating, UL/cUL listed, high retention filter to 25 microns.
- .3 Sight glass, 4 MPa pressure rating, solid brass hermetically sealed viewing window.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- .2 Remove refrigerant from existing heat pump systems before removing existing refrigerant piping..

### **3.2 BRAZING PROCEDURES**

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

### **3.3 PIPING INSTALLATION**

- .1 General:
  - .1 Provide a system piping schematic for the refrigeration systems and submit to and receive approval by the Original Equipment Manufacturer and the Engineer prior to installation. Provide solenoid and thermostatic valves for each refrigerant circuit.
  - .2 Drill holes in exterior walls as required to install piping from the condensing unit to the fan coil unit. Insert sleeves in the openings, caulk and fasten in place. Caulk between refrigerant piping and sleeves.
  - .3 Where refrigerant pipes and conduits pass through exterior wall, seal around piping in accordance with RCABC standards. Alternatively provide a curb and piping enclosure over the curb and extend the piping horizontally to the condensing device.

- .4 Refrigerant piping shall be supplied and installed by an experienced, qualified and "licensed" Refrigeration Contractor.
  - .5 Refrigerant piping shall be refrigerant grade copper ASTM B88 type "L". Install to CSA Standards, B-51 and B-52 Mechanical Refrigeration Codes. Confirmation to these requirements and those of regulating authorities requires that the applicable requirements for brazing procedures, quality control and other related requirements shall be followed.
  - .6 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.
  - .7 Provide as a minimum, all of the components shown on the refrigeration schematic. All piping and fittings shall be new and sized for the refrigerant supplied with refrigerant unit.
  - .8 All systems shall have provisions to handle safely the refrigerant charge for servicing purposes without venting the charge to atmosphere. This may include properly located stop valves, liquid transfer valves and refrigerant storage tanks for the safe transfer, discharge and disposal of the charge without venting the charge to the atmosphere.
  - .9 Provide stop valves at the locations shown on the piping schematic.
  - .10 Refrigerant lines crossing an open space shall be not less than 7.5 ft, (2.3 m) above the floor.
  - .11 Support piping on C Block supports on the roof.
- .2 Hot gas lines:
- .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
  - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
  - .3 Provide inverted deep trap at top of risers.
  - .4 Provide double risers for compressors having capacity modulation.
    - .1 Large riser: install traps as specified.
    - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

### **3.4 PIPING INSULATION**

- .1 Insulate suction lines with ½" thick, (12 mm), neoprene foam, (Armaflex), preformed pipe insulation. Seal joints with approved sealant.
- .2 Exposed piping on roof shall be insulated with 1" thick, (25mm) and covered with aluminium jacket with all joints sealed with silicone sealant.

### **3.5 FIELD QUALITY CONTROL**

- .1 Ambient temperatures to be at least 13degrees C for at least 12 hours before and during dehydration.
- .2 Use copper lines of largest practical size to reduce evacuation time.
- .3 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .4 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .5 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
  - .1 Twice to 14 Pa absolute and hold for 4 h.
  - .2 Break vacuum with refrigerant to 14 kPa.
  - .3 Final to 5 Pa absolute and hold for at least 12 h.
  - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
  - .5 Pressure test shall be witnessed by the Engineer and the system demonstrated to hold a vacuum of 100 microns for a period of 24 hours. Written acceptance of this refrigerant test shall be obtained prior to charging the system with refrigerant.
- .6 Charging:
  - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
  - .2 Refrigerant shall be (R-410a) (R-134a). (*Select type of refrigerant*)
  - .3 With compressor off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
  - .4 Re-purge charging line if refrigerant container is changed during charging process.
- .7 Checks:
  - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
  - .2 Start-up and Commissioning of the refrigeration system shall be executed in the presence of the factory representative, the Consultant and the Commissioning Agent.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1    Section Includes:
  - .1    Materials and installation of low-pressure metallic ductwork, joints and accessories.
  - .2    Sustainable requirements for construction and verification.

**1.2                REFERENCES**

- .1    American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2    American Society for Testing and Materials International, (ASTM).
  - .1    ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2    ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
  - .3    ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3    Department of Justice Canada (Jus).
  - .1    Canadian Environmental Protection Act (CEPA), 1999, c. 33 .
- .4    Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1    Material Safety Data Sheets (MSDS).
- .5    National Fire Protection Association (NFPA).
  - .1    NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2    NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  - .3    NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6    Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1    SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
  - .2    SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
  - .3    IAQ Guideline for Occupied Buildings Under Construction 1995 1st Edition.
- .7    Transport Canada (TC).
  - .1    Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

**1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials for the following:
  - .1 Sealants.
  - .2 Tape.
  - .3 Proprietary Joints.
- .3 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .4 Submit Indoor Air Quality (IAQ) Management Plan in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

**1.4 QUALITY ASSURANCE**

- .1 Certification of Ratings:
  - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Protect on site stored or installed absorptive material from moisture damage.

**Part 2 Products**

**2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed
- .2 Seal classification:
  - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
  - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.
  - .3 Class C: transverse joints and connections made air tight with sealant. Longitudinal seams unsealed.
  - .4 Unsealed seams and joints.

## **2.2 SEALANT**

- .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

## **2.3 DUCT LEAKAGE**

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

## **2.4 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
  - .1 Rectangular: Centreline radius: 1.5 times width of duct.
  - .2 Round: smooth radius or five pieces. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 With double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
  - .2 Tapered fitting for round ducts.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
  - .1 Full radiused elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

## **2.5 FIRE STOPPING**

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Fire Protection and Safety Consultant requirements.
- .2 Fire stopping material and installation must not distort duct.

## **2.6 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA.

- .3 Joints: to ASHRAE SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

## 2.7 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to ASHRAE and SMACNA.
  - .3 Hangers: black steel angle with galvanized steel rods to ASHRAE and SMACNA as per the following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp steel plate washer.
  - .3 For steel beams: manufactured beam clamps:

## Part 3 Execution

### 3.1 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
- .3 Support risers in accordance with ASHRAE, SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

### 3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.

- .3 Hanger spacing: in accordance with SMACNA as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

### **3.3 WATERTIGHT DUCT**

- .1 Provide watertight duct for:
- .1 Fresh air intake.
  - .2 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams.
- .1 Solder or weld joints of bottom and side sheets.
  - .2 Seal other joints with duct sealer.
  - .3 Slope header ducts down toward risers.
- .3 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and trap primer and discharging to open funnel drain as indicated.

### **3.4 LEAKAGE TESTS**

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Do not install additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .6 Complete test before performance insulation or concealment Work.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1    Section Includes:
  - .1        Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.
  - .2        Sustainable requirements for construction and verification.

**1.2                REFERENCES**

- .1    Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1        Material Safety Data Sheets (MSDS).
- .2    Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1        SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

**1.3                SUBMITTALS**

- .1    Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1        Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
    - .1           Flexible connections.
    - .2           Duct access doors.
    - .3           Turning vanes.
    - .4           Instrument test ports.
  - .2        Submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3    Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
  - .1        Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .4    Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5    Instructions: submit manufacturer's installation instructions.
- .6    Manufacturer's Field Reports: manufacturer's field reports specified.

- .7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

## **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .2 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

### **2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame 2 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m<sup>2</sup>.

### **2.3 ACCESS DOORS IN DUCTS**

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
  - .1 Up to 300 x 300 mm: two sash locks [complete with safety chain.
  - .2 301 to 450 mm: four sash locks [complete with safety chain.
  - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
  - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
  - .5 Hold open devices.
  - .6 300 x 300 mm glass viewing panels.

**2.4 TURNING VANES**

- .1 Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA.

**2.5 INSTRUMENT TEST**

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
  - .1 Size:
    - .1 600 x 1200 mm for person size entry.
    - .2 600 x 600 mm for servicing entry.
    - .3 300x 300 mm for viewing.
    - .4 As indicated for kitchen exhaust duct.
  - .2 Locations:

- .1 Fire and smoke dampers.
- .2 Control dampers.
- .3 Devices and ducts requiring maintenance.
- .4 Required by code.
- .5 Reheat coils.
- .3 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
    - .2 Locate to permit easy manipulation of instruments.
    - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 In mixed air applications in locations as approved by Consultant
      - .3 At inlet and outlet of coils.
      - .4 Downstream of junctions of two converging air streams of different temperatures.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### **3.3 CLEANING**

- .1 Perform cleaning operations in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1 Section Includes:
  - .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.
  - .2 Sustainable requirements for construction and verification.

**1.2                REFERENCES**

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3                SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures
- .2 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 Consultant will make available 1 copy of systems supplier's installation instructions.

**Part 2            Products**

**2.1                SUSTAINABLE REQUIREMENTS**

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

**2.2 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.3 SINGLE BLADE DAMPERS**

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm or as indicated.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

**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 where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Engineer.

**END OF SECTION**

**Part 1        General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1    Fans, motors, accessories and hardware for commercial use.
  - .2    Sustainable requirements for construction and verification.

**1.2            REFERENCES**

- .1    Air Conditioning and Mechanical Contractors (AMCA)
  - .1    AMCA Publication 99-[2003], Standards Handbook.
  - .2    AMCA 300-[1996], Reverberant Room Method for Sound Testing of Fans.
  - .3    AMCA 301-[1990], Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

**1.3            SYSTEM DESCRIPTION**

- .1    Performance Requirements:
  - .1    Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
  - .2    Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
  - .3    Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
  - .4    Sound ratings: comply with AMCA 301, tested to AMCA 300.

**1.4            SUBMITTALS**

- .1    Product Data:
  - .1    Submit manufacturer's printed product literature, specifications and performance information.
- .2    Shop Drawings:
  - .1    Submit shop drawings and product data.
- .3    Provide :
  - .1    Fan performance curves showing point of operation, bhp and efficiency.
  - .2    Sound rating data at point of operation.
- .4    Indicate:
  - .1    Motors, sheaves, bearings, shaft details.
  - .2    Minimum performance achievable

- .5 Quality assurance submittals: submit the following.
  - .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.
- .6 Closeout Submittals:
  - .1 Provide operation and maintenance data for incorporation into manual specified in Section.

## **1.5 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section [01 35 29.06 - Health and Safety Requirements].

## **1.6 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials.
    - .1 Spare parts to include:
      - .1 Matched sets of belts.
    - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
      - .1 Bearings and seals.
      - .2 Addresses of suppliers.
      - .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for disposal and recycling in accordance with Section 02 41 99, Demolition and Disposal.

## **Part 2 Products**

### **2.1 IN-LINE CENTRIFUGAL FANS**

- .1 In line fans shall meet the quality and performance specified in the Equipment Schedules.
- .2 Characteristics and construction: Centrifugal fan wheels, with axial flow construction and direct drive. Inlet and outlet collars, 100 mm diameter.

- .3 Provide local disconnect switch.
- .4 Provide RSK4, spring loaded backdraft damper.
- .5 CSA approved.

**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 FAN INSTALLATION**

- .1 Install fan as indicated, complete with resilient mountings and Seismic Controls, flexible electrical leads and flexible connections.
- .2 Provide balancing damper for air balance.

**3.3 ANCHOR BOLTS AND TEMPLATES**

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified.

**3.4 FIELD QUALITY CONTROL**

- .1 Verification requirements include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Low-emitting materials.

**3.5 CLEANING**

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

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 23 23 00 - Copper Tubing and Fittings Refrigerant.

**1.2                REFERENCES**

- .1        Air-Conditioning and Refrigeration Institute (ARI)
  - .1        ARI 210/240-1994, Standard for Unitary Air Conditioning and Air-Source Heat Pump Equipment.
- .2        American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1        ASHRAE Standard 15-2001, Safety Standard for Refrigeration Systems.
- .3        Canadian Standards Association (CSA International)
  - .1        CAN/CSA-C273.3-M9 (R2001), Performance Standard for Split-System Central Air-Conditioners and Heat Pumps.
- .4        Environment Canada, (EC)/Environmental Protection Services (EPS)
  - .1        EPS 1/RA/2-1996, Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
  - .2        Environment Canada-1994, Ozone-Depleting Substances Alternatives and Suppliers List.

**1.3                SHOP DRAWINGS AND PRODUCT DATA**

- .1        Submit shop drawings in accordance with Sections 01 33 00 - Submittal Procedures.
- .2        Indicate:
  - .1        Capacities.
  - .2        ARI Ratings.
  - .3        Electrical requirements
  - .4        Sound Power levels.
  - .5        Installation instructions.
  - .6        Start-up Instructions.
  - .7        O&M, Instructions.

**1.4                WASTE MANAGEMENT AND DISPOSAL**

- .1        Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2        Remove and recycle refrigerant from the existing heat pump systems.

**1.5            WARRANTY**

- .1        For heat pumps, the 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 5 years.
- .2        Contractor hereby warrants heat pumps in accordance with GC 24, but for 5 years.

**Part 2        Products**

**2.1            GENERAL**

- .1        Heat pumps: carry ARI or CSA certification seal.

**2.2            REFRIGERANTS**

- .1        Type of Refrigerant: R-410A

**2.3            AIR-SOURCE HEAT PUMP**

- .1        General:
  - .1        Two component unit consisting of indoor unit with fan and cooling coil; outdoor unit with compressor, condenser coil and reversing valve, linked together with liquid and hot gas refrigerant piping system.
  - .2        Performance data: as indicated.
    - .1        Capacity, configuration, and electrical: as noted in the Equipment Schedules.
    - .2        General
      - .1        Indoor fan and coil: 3 speed , 212, 260, 2924 cfm.
      - .2        Maximum sound level 36 dBA
      - .3        SEER: 15.0 or 16.0 as noted in the Equipment Schedules
      - .4        Controlled by DDC system.
      - .5        Disposable air filter
      - .6        Refrigerant lines : to match connections sizes, c/w electric expansion valves.
      - .7        Other components to include: reversing valve, suction line accumulator, devices to prevent rapid compressor cycling, refrigerant line tubing, fittings and service ports.
      - .8        Controls, safety devices, factory pre wired.
  - .3        Features and Accessories:
    - .1        Stamped, decorative coil guard. Cabinet with powder coat finish and baked on primer.
    - .2        Internal pressure relief on compressor.
    - .3        Scroll compressor.

- .4 Factory installed filter drier.
- .5 Complete controls systems compatible with furnace controls and low ambient lock-out capability.
- .6 Composite fan base Pan.
- .7 Extended, 10 year limited parts and compressor warranty.
- .4 Refrigeration piping:
  - .1 Between outdoor condensing unit and the indoor fan/coil, complete with refrigerant metering devices and valves.
  - .2 Refer to Section 23 23 00 - Copper Tubing and Fittings - Refrigerant.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install where indicated on drawings and in accordance with manufacturer's instructions.
- .2 Install outdoor units on concrete housekeeping pads in accordance with established practice. Adjust/modify existing bollards as required to accommodate the new outdoor heat pumps.
- .3 Provide seismic rated rubber isolators under the condensing unit.
- .4 Install indoor cooling coils in furnace supply air ductwork. Seismically support the units.
- .5 Install indoor fan coil in ceiling space and connect to the existing ductwork. Seismically support the unit.
- .6 Route the refrigerant lines through the exterior wall and into the building following the existing refrigerant lines and control wiring. Provide insulation around lines and caulk. Exterior refrigerant lines to be insulated with 25 mm thick closed cell foam insulation and covered with an aluminium jacket. Refer to Section 23 23 00 Refrigerant Piping.
- .7 **START-UP AND COMMISSIONING**
- .8 Manufacturer to certify installation.
- .9 Manufacturer's trained technician to start unit and fill out a start up refrigerant report. Submit one copy to Consultant and three copies to Contractor to insert in Manuals.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 01 11 00 – Summary of Work
- .2      Section 01 77 00 - Closeout Submittals

**1.2                GENERAL**

- .1      This Project Specification, including all appendices, shall be deemed to cover the complete installation ready for operation. Consequently, minor details not necessarily shown or specified but necessary for the proper functioning of the installation, including equipment serviceability, shall be included in the Work, the same as if shown in the Project Specification.
- .2      The Work shall include but not be limited to the supply of all labour, materials, equipment and supervision to complete the Work as required by the Contract Documents.
- .3      Existing security, smoke control, fire alarms and monitoring shall be uninterrupted by the installation. Re-use existing fire/smoke controls to shut down air handling systems in the event of a fire.
- .4      Carefully examine the existing building, local conditions affecting the Work and building site, together with all other trades to make sure that Work under this Specification can be satisfactorily carried out without changes. Work of all trade Divisions shall be examined, before commencing Work, and any defect or interference affecting Work shall be reported at once.
- .5      The Contractor, when estimating, shall visit the site and make himself familiar with all existing conditions and allow for same in his tender.

**1.3                INTENT**

- .1      Work shall be in accordance with the specifications and their intent, complete with all necessary components, including those not normally shown or called for, and shall be ready for operation before acceptance.
- .2      Any reference to the “engineer” or “consultant” shall mean Prism Engineering Ltd.
- .3      The work “provide” shall mean “supply and install” unless otherwise indicated.
- .4      The new installation shall meet the existing building and PWGSC standards in all aspects.

**1.4                INTEROPERABILITY REQUIREMENTS**

- .1      All DDC equipment shall be BACnet compatible.

**1.5                CONTROLS CONTRACTOR REQUIREMENTS**

- .1      The Control System to be installed shall be Delta Controls, Reliable Controls, or approved equivalent.

- .2 The EMCS Contractor shall have an established working relationship with the Control System Manufacturer of not less than three years.
- .3 The EMCS Contractor shall have a local office in the Metro Vancouver for the past 5 years. The local Controls Contractor Office shall be staffed by trained personal capable of maintaining the system and training client staff. The local office shall have local availability of replacement parts
- .4 The EMCS Contractor shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.
- .5 EMCS Contractor shall demonstrate capacity to respond emergency calls by a local contractor (or his representative) within a two hours period of the call.
- .6 The EMCS Contractor shall provide 24-hour response in the event of a customer call.

## **1.6 CODES, STANDARDS AND PERMITS**

- .1 Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section. All equipment shall be installed in accordance with the latest requirements of the following:
  - .1 The local Building Code
  - .2 The B.C. Building Code
  - .3 The Workers' Compensation Act
  - .4 The Canadian Electrical Code
  - .5 The Canadian Standards Association
  - .6 National Fire Protection Association
- .2 Electric equipment shall bear CSA labels and, where applicable, ULC label certifying compliance with test standards of these agencies.
- .3 Obtain all required permits and pay all fees therefore and comply with all provincial, municipal and other legal regulations, codes and by-laws applicable to the work.

## **1.7 SECURITY CLEARANCES**

- .1 Personnel employed on this project may be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter the premises.
- .2 Personnel may 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.

## **1.8 LIABILITY**

- .1 Assume responsibility for laying out work and for damage caused by improper execution of work.
- .2 Protect finished and unfinished work from damage.

- .3 Take responsibility for condition of materials and equipment supplied and protect until work is completed and accepted.
- .4 The owner shall have recourse in tort for any negligent action by the contractor or his representatives.

**1.9 INSURANCE**

- .1 The Contractor shall provide and show proof of, at his expense, insurance in accordance with Brookfield and PWGSC requirements.
- .2 The Contractor shall carry full employee's liability insurance for the whole of the work in accordance with the Workers' Compensation Act.

**1.10 SIGNS AND PUBLICITY**

- .1 Neither the Contractor nor anyone directly or indirectly employed by them, shall post any site signs, nor release any publicity reports, photographs, sketches, plans or other information, orally or in writing, concerning the work performed or to be performed, without the prior written acceptance of the Owner's Representative.

**1.11 PROJECT MANAGER**

- .1 The Contractor shall identify a Project Manager who will be responsible for all aspects of the project (including co-ordination of subcontractors and suppliers, permits, installation, commissioning and contract administration).
- .2 The Owner's Representative reserves the right to interview the prospective project manager to evaluate their understanding and ability to complete the project.

**1.12 EXAMINATION OF SITE**

- .1 A site visit is recommended for all the contractors before tendering the project. Examine all local and existing conditions on which the work is dependent.
- .2 No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit the site.
- .3 When the contract documents do not contain sufficient information for the proper selection of equipment for bidding, notify the design authority during the tendering period. If clarification is not obtainable, allow for the most expensive arrangement. Failure to do this shall not relieve the contractor of responsibility to supply the intended equipment.
- .4 Check drawings of all trades and survey the site to verify space availability for the installation. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent without written approval.
- .5 Wall locations, ceiling layout, heights, and equipment locations shall be verified on site. Failure to do this shall not relieve the contractor of the responsibility for correct location of mechanical systems and equipment.

**1.13 WORKMANSHIP**

- .1 Workmanship shall be in accordance with PWGSC standards and well-established practice and standards accepted and recognized by design authorities and the trade.
- .2 Employ only tradesmen holding valid provincial trade qualification certificates. Tradesmen shall perform only work that their certificate permits.

**1.14 NEW PRODUCTS ONLY**

- .1 All products used in this installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of 1 year. This installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.

**1.15 SHOP DRAWINGS**

- .1 Shop Drawings shall be submitted as per Section 01 33 00 – Submittal Procedures

**1.16 AS-BUILT DRAWINGS**

- .1 As-Built drawings shall be submitted as per Section 01 78 00 – Closeout Submittal

**1.17 OPERATING AND MAINTENANCE MANUALS**

- .1 Operating and Maintenance Manuals shall be submitted as per Section 01 78 00 – Closeout Submittal.

**1.18 COMMISSIONING**

- .1 The control system must be commissioned and tested at the end of the work as per Section 01 91 13 – General Commissioning (Cx) Requirements.
- .2 Results of all tests shall be documented by the Contractor and a hard copy of the commissioning sheets and trends covering a continuous period shall be submitted to Prism for review.

**1.19 DEMONSTRATION**

- .1 A complete demonstration and readout of the capabilities of the monitoring and control system shall be performed as per Section 01 79 00 Demonstration and Training.
- .2 The contractor shall dedicate a minimum of 2 hours on-site with the Owner and his representatives for a complete functional demonstration of all the system requirements.
- .3 Demonstration shall be scheduled and witnessed by Brookfield Commissioning Manager.
- .4 The demonstration constitutes a joint acceptance inspection, and acceptance of the delivered system for on-line operation.

**1.20 TRAINING**

- .1 Training for the building operators and manager shall be performed as per Section 01 79 00 Demonstration and Training.
- .2 A training of the control system capabilities shall be performed. The contractor shall dedicate a minimum of 4 hours on-site session with the Owner and his representatives for operator training.
- .3 Training shall include but not limited to the explanation of system operation and capabilities, system navigation, setpoint adjustments, alarm acknowledge, weekly schedules, password settings, graphic screens creation and changes, trend log settings and visualization, database management, etc.

**1.21 WARRANTY**

- .1 At the end of the final start-up/testing and commissioning, if equipment and systems are operating satisfactorily to the Owner and Owner's Representative, the Owner shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of warranty.
- .2 Labour & materials for control system specified shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. Control System failures during the warranty period shall be adjusted, repaired, or replaced at no charge or reduction in service to the Owner.
- .3 The warranty shall provide all material, parts and labour, including labour provided on an emergency response basis outside of normal working hours. Labour shall include any related travel time and other related costs associated with providing the warranty service.
- .4 A detailed service report must be filed with the Owner after each warranty visit, detailing the work performed, time spent, devices replaced or repaired, and the personnel involved.
- .5 Emergency calls during the warranty period shall be addressed by the Contractor within four (4) hours of notification. Service shall be available 24 hours per day, seven days a week. The Owner shall be provided an emergency phone number for contacting service personnel. The service call shall only be chargeable if inspection reveals any defect not directly covered under the terms of the specification.
- .6 Warranty shall be submitted as per Section 01 78 00 – Closeout Submittal

**1.22 OWNERSHIP OF PROPRIETARY MATERIAL**

- .1 All project developed hardware and software shall become the property of the Engineer. These include but are not limited to:
  - .1 Project graphic images
  - .2 Record drawings
  - .3 Project database
  - .4 Job-specific application programming code
  - .5 All documentation

**1.23 ACCEPTANCE**

- .1 The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner.
- .2 Any tests that cannot be performed due to circumstances beyond the control of the Controls Contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer's representative. A deficiency amount will be held at Substantial Completion for such tests. Deficiency amounts will be released after tests are performed and documented to the satisfaction of the Engineer.
- .3 Warranty shall start from the date of all deficiencies are corrected and tests are performed and documented to the satisfaction of the Engineer.

**1.24 SUBSTANTIAL PERFORMANCE**

- .1 Once the above basic requirements are met and all other features of the system are complete and acceptable, Substantial Performance shall be granted. A deficiency list shall be prepared and holdbacks applied. All deficiencies shall be corrected prior to Total Performance. Warranty shall start from the date of Substantial Performance of the work.

**Part 2 Products**

**2.1 Not Used**

**Part 3 Execution**

**3.1 Not Used**

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures
- .2      Section 25 05 01 – EMCS General Requirements

**1.2                GENERAL**

- .1      The objective of the work is to implement a DDC control system with remote access via internet to HVAC equipment at the DFO Cultus Lake Laboratory. Two new heat pump units, one new exhaust fan, new control dampers are to be provided with new DDC controls. New controls are also to be provided for the existing boiler, circulation pumps, valves and heating coils. The heat pump units shall be provided with BACnet boards for DDC interface.

**1.3                WORK COVERED BY CONTRACT DOCUMENTS**

- .1      Provide and install all hardware components necessary for a complete system installation, including network and communications devices; DDC controllers; field devices of all types, transformers, conduits, raceways, and wiring including power and network cabling;
- .2      Provide a computer interface c/w monitor, keyboard and mouse to access the DDC controls system. Locate the interface in the boiler room or where instructed by DFO's site representative.
- .3      The existing boiler controls and hot water temperature reset controls shall remain as the primary control for the boiler and hot water system. The contractor shall supplement the existing controls and new monitoring devices and shall confirm that the existing controls are operating correctly and in sequence with the new controls.
- .4      The DDC contractor shall replace the existing Tekmar controllers with new controls for heat pumps, exhaust fan, reheat coils, modulating damper actuators, circulation pumps and temperature sensors connected to the new DDC system.
- .5      Provide control for new exhaust fan EF-101.
- .6      Existing smoke detectors and fire alarm interface shall be retained and hardwired to the new heat pump units to shut them off in the event of a fire detection.
- .7      A web server shall be provided and installed in the boiler room (or where designed by the owner). All graphic screens shall reside in the web server. Access to the DDC system shall be via internet using a standard web browser. Note that internet access shall be provided by the DDC contractor.
- .8      Provide and install all required devices and coordinate with internet provider for remote access to the DDC system via Internet. One year fully paid contract with an internet provider shall be included in the price for this project. The internet service shall be an independent, dedicated connection.
- .9      BACnet interface are to be provided in the heat pump units control panel by the heat pump unit manufacturer. DDC contractor shall connect the interface to the DDC network

and map all the applicable points. A graphic screen with these information shall be created and linked to the heat pump unit graphic screen;

- .10 Graphic screens shall be created for all equipment controlled by the DDC system as per this specification. Graphic screens shall be submitted and reviewed by Prism;
- .11 Provide trend logs as required to reflect the system operation as per this specification and to allow the building operator analysis and troubleshooting;
- .12 Provide all required labour and supervision for the installation, calibration, adjustments, checkouts, commissioning of all components and devices provided.
- .13 Patch and touch up paint to match existing or a provide cover plate where existing thermostats and devices were removed and/or replaced with new DDC sensors.
- .14 The DDC system including new BACnet interface shall be fully tested and commissioned to prove point functionality and communication after installation. Coordinate work with Commissioning Manager,
- .15 Provide as built drawings, O&M manuals, commissioning reports, etc. with complete information of the installed system;
- .16 Provide a complete training and demonstration of the control system capabilities as per this specification;
- .17 Provide one year Warranty as per this specification.

#### **1.4 WORK BY OTHERS**

- .1 Co-operate and co-ordinate with other Contractors in carrying out their respective works and carry-out instructions from Engineer.
- .2 If any part of work under this Contract depends on proper execution by or relies upon work of another Contractor, report immediately to the Engineer, in writing, any situations which may interfere with proper execution of Work.

#### **1.5 CONTRACTOR USE OF PREMISES**

- .1 Limit use of premises for Work, and for storage to allow:
  - .1 Owner occupancy.
  - .2 Work by other contractors.
- .2 Co-ordinate use of premises under direction of Owner's Representative.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .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 to match existing or adjoining work.
- .6 At completion the work: ensure premises condition for the work area to be equal or better than that which existed before the work started.

**1.6 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.

**1.7 WORK IN EXISTING BUILDINGS**

- .1 All work on site shall be co-ordinated with the Owner's Representative so as to minimize disruptions. Execute work with least possible interference or disturbance to building operations, occupants, and normal use of premises. Arrange with Owner's Representative to facilitate execution of work.
- .2 Work taking place outside of the occupied areas that does not involve power or comfort systems interruptions may occur during the day with prior approval from the Owner's Representative. Work in mechanical rooms can be performed during occupied periods between 8:00AM and 4:00PM and anytime if required to complete the work. Coordinate with the Maintenance Team Leader, in advance the areas and intended working hours.
- .3 Installation of equipment in occupied areas must take place outside of regular business hours. Desks, equipment and furniture must be covered when the work is taking place. Work taking place outside of the occupied areas that does not involve power interruptions may occur during the day with prior approval from the Owner's Representative.
- .4 Include in Price any overtime that may be required to tie-in services at night or on weekends.
- .5 Obtain approval from the Owner's Representative prior to penetrating any structural surfaces including floor slabs. Obtain from the Owner's Representative approval of locations of all penetrations prior to commencing work. Contractor shall replace/repair any building services that are damaged due to this construction (example: drilling through concrete floors) at no extra cost.
- .6 Carefully route new conduits and other new services so that they do not interfere with existing installation. Arrange and pay for any necessary relocation of existing conduit, cable tray, bus duct or any other services required for the proper installation of new Work.
- .7 Removed equipment and material shall become the property of the Contractor and shall be removed from site unless otherwise requested by the Owner's Representative.
- .8 After completion of work in ceiling space, arrange and pay for the repair of any damaged or dislodged fireproofing or other building materials.
- .9 In area with solid ceilings, electrical and systems junction boxes along with associated wire and conduit shall be relocated to areas where ceiling access is possible, or access panels may be provided with the approval of the Owner's Representative.
- .10 All Contractors shall exercise due care and diligence in working in the occupied areas. Keep the job reasonably clear of waste material and rubbish at all times during progress of the work. Clean up and restoration of the work area shall occur after each day's installation to ensure that no disruption to the work area takes place.

- .11 Protect all existing services and make good any damage occasioned by the work in this contract.
- .12 The Owner reserves the right to complete and/or repair any work that is not in operating condition, beyond scheduled shut downs, in order to maintain the Owner's operation.

**1.8 CONTINUITY OF EXISTING SERVICES**

- .1 Keep existing building in operation at all times with minimum length of shutdown periods.
- .2 Obtain permission of the Owner before shutting down or disconnecting electrical and fire protection services. Shutdowns of systems are to be co-ordinated with the Brookfield site manager.
- .3 Co-operate with the Owner and other contractors on the job and provide necessary services so that existing building can be kept in operation at all the time.
- .4 Where Work involves breaking into or connecting to existing services, give Owner's Representative 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.
- .5 Submit schedule to and obtain approval from Owner's 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 Engineer to maintain critical building and tenant systems.
- .7 Where unknown services are encountered, immediately advise Engineer and confirm findings in writing.

**1.9 CLEANING**

- .1 The Contractor shall be responsible to keep the building, site, and premises clean and tidy with respect to his work at all times.
- .2 On completion, all dirt and rubbish for which the Contractor is responsible shall be removed from the site and premises and the whole left clean and tidy. All soiling of finished walls, floors, ceilings, carpets, or other surfaces, caused by the Contractor shall be cleaned up or made good by the Contractor.
- .3 All control panels, etc., shall be thoroughly cleaned of dust, dirt, and debris before start-up and hand-over.

**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    Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

**1.2                RELATED SECTIONS.**

- .1    Section 01 11 00 – Summary of Work
- .2    Section 01 33 00 - Submittal Procedures.
- .3    Section 01 78 00 – Closeout Submittal
- .4    Section 25 05 01 - EMCS: General Requirements.

**1.3                REFERENCES**

- .1    Canadian Standards Association (CSA International).
  - .1    CSA C22.1-[02], The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

**1.4                DEFINITIONS**

- .1    For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.5                LANGUAGE**

- .1    Identification shall be in English.

**Part 2            Products**

**2.1                NAMEPLATES FOR PANELS**

- .1    Identify by laminated plastic, 3 mm thick, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.
- .2    Sizes: 25 x 67 mm minimum.
- .3    Inscriptions: machine engraved to identify function.
- .4    Identifiers shall match record documents.

**2.2                CMMS IDENTIFICATION SYSTEMS**

- .1    Apply CMMS identification system to new work.
- .2    Plastic laminate nameplate mechanically fastened to each piece of equipment by contractor.

- .3 Colours: White letters, orange background.
- .4 Sizes: Only ¾" x 2 ½" lamacoids shall be used for CMMS identification
- .5 A ¼" hole shall be placed on the right hand side to facilitate attachment to the equipment if the need arises.
- .6 Before starting work, obtain written approval of identification system from Brookfield. O&M.

### **2.3 NAMEPLATES FOR FIELD DEVICES**

- .1 Identify by plastic encased cards attached by plastic tie.
- .2 Sizes: 50 x 100 mm minimum.
- .3 Lettering: minimum 5 mm high produced from laser printer in black.
- .4 Data to include: point name and point address.

### **2.4 NAMEPLATES FOR ROOM SENSORS**

- .1 Identify by stick-on labels using point identifier.
- .2 Letter size: to suit, clearly legible.

### **2.5 WARNING SIGNS**

- .1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS.

### **2.6 WIRING**

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 All wiring and cabling, including that within factory-fabricated panels, shall be labelled at each end within 2" of termination with a cable identifier. Cable identifier shall be shown on and match record documents.
- .3 Colour coding: Use colour coded wiring in communications cables, matched throughout system.
- .4 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

### **2.7 CONDUIT**

- .1 Junction and Pull boxes shall be adequate tagged to indicate its use for DDC system. Self sticker labels with controls company logo could be used for that purpose.
- .2 Identify each wire and cable at every termination point. Identify all conduits with "neat" colour bands at no more than 7.5 m intervals and on both sides of walls and floors.

**Part 3          Execution**

**3.1                NAMEPLATES AND LABELS**

- .1      Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.
- .2      Locations: In conspicuous location to facilitate easy reading and identification from operating floor.
- .3      Protection: Do not paint, insulate or cover in any way.
- .4      All plug-in components shall be labelled such that removal of the component does not remove the label.

**3.2                EXISTING PANELS**

- .1      Correct existing nameplates and legends to reflect changes made during Work.
- .2      Where new points are added or where controllers are replaced, all cabling, wiring, and device tags shall be updated as required and as built drawings shall be issued.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 01 11 00 Summary of Work
- .2      Section 01 33 00 - Submittal Procedures.
- .3      Section 01 78 00 - Closeout Submittals.
- .4      Section 25 05 01 – ECMS General Requirements

**Part 2            Products**

**2.1                NOT USED**

**Part 3            Installation**

**3.1                INSTALLATION STANDARDS**

- .1      The intention of this clause is to guide the Contractor as to the required quality of installation.
- .2      All installations shall be performed by skilled certified technicians and trades people and meet the existing building and DFO standards in all aspects.
- .3      All equipment installed shall be mechanically stable and, as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of the equipment.
- .4      Contractor shall continually monitor the installation for code compliance and quality of workmanship.
- .5      Contractor shall arrange for field inspections by Prism Engineering.
- .6      Equipment shall be installed to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.
- .7      Equipment shall be installed in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation and with no condensate traps.
- .8      Cooperate with the construction team as a whole, to keep the job reasonably clear of waste material and rubbish at all times during progress of the work. In occupied areas. Clean-up and restoration of the work area shall occur after each day's installation to ensure that no disruption to the work area takes place.
- .9      Installation of equipment in occupied areas must take place outside of regular business hours. Desks, equipment and furniture must be covered when the work is taking place. Work taking place outside of the occupied areas that does not involve power interruptions may occur during the day with prior approval from the Owner's Representative.

- .10 Keep existing building in operation at all times with minimum length of shutdown periods. Obtain permission of the Owner before shutting down or disconnecting existing control systems, electrical and fire protection services.
- .11 All points associated with a single zone or an individual system shall be connected to the same stand alone panel, and associated terminal unit controller.
- .12 Patch and touch up paint to match existing or a provide cover plate where sensors were removed or replaced by new DDC sensors.

### **3.2 ELECTRICAL WORK BY THE CONTROLS CONTRACTOR**

- .1 All wiring required for devices supplied under this Specification, regardless of the voltage, shall be the responsibility of the Controls Contractor.
- .2 Provide copper conductor and EMT conduit for all wiring. Teck cable shall only be used where required for short flexible connections to equipment.
- .3 Provision of control panels, pilot lights, selectors, relays, etc., required for the proper operation of the control systems.
- .4 Conduit and wiring from the starter control circuits to the mechanical system control panels including 110 V wiring.
- .5 Conduit and wiring required for the interlocking of mechanical system motor starters as required for the proper operation of the control system.
- .6 Wiring from pilot devices, relays, contactors, or other control interface devices required for the proper operation of the control system.
- .7 Wiring from spare 15 amp circuit breakers in power panels for line voltage power sources where required by control system. Circuit breakers shall be locking type.
- .8 Power wiring and control wiring to stand alone panels and terminal unit controllers.
- .9 Controls Contractor shall confirm all wiring connections between controllers and field devices and provide a copy of the End-to-End Checkout Sheet for every control panel.
- .10 Controls Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with termination identified at the job site.
- .11 Wiring of mechanical component controls, i.e., boilers, chillers, etc.

### **3.3 CONTROL AND INTERLOCK WIRING**

- .1 All control and interlock wiring shall comply with the national and local electrical codes as well as the following clauses.
- .2 All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- .3 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with local codes.
- .4 Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.
- .5 Adhere to Division 26 requirements for installation in raceways.

- .6 Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length, shall only be used for flexible connections to equipment and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.
- .7 Where there is no alternative to supplying equipment that is not CSA certified, submit such equipment to Inspection Authorities for special inspection and obtains approval before delivery of equipment to site. Such equipment must be individually identified in the Contractor's proposal.
- .8 Use coded conductors throughout with different coloured conductors for each phase and white wire for neutral.
- .9 All wiring through the building, in mechanical rooms and service rooms shall be in conduit. Provide 600 mm, B-X flexible connection to input and output devices where required for servicing or to accommodate vibration.
- .10 Size and type of low voltage control signal wiring shall be suitable for the service for which it will be put to use and be the responsibility of this Contractor; minimum wire size #18 AWG.
- .11 Identify each wire and cable at every termination point. Identify all conduits with "neat" colour bands at no more than 7.5 m intervals and on both sides of walls and floors.
- .12 Low voltage wiring to input and output devices from Building Controller and Application Specific Controllers is not required to be installed in conduit except as noted. Use plenum rated wire in areas used as return air plenums. Provide sleeves where wires pass through walls and floors. Support wires from structure or fixed equipment in ceiling spaces at minimum 2 m intervals.
- .13 Junction and Pull boxes shall be adequate tagged to indicate its use for DDC system. Self sticker labels with controls company logo could be used for that purpose.

### **3.4 COMMUNICATION WIRING**

- .1 Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run inside conduit and separately from other wiring.
- .2 All communication wiring between main Building Controller and the Operator Interface shall be installed in conduit.
- .3 All BACnet MS/TP networks shall communicate error free at a baud rate of 76,800 bps.
- .4 Low capacitance cable with less than 15 Pico farads per foot shall be provided for MS/TP networks to for stable and less network communication errors.
- .5 All exposed connection for external communication device as modem, laptop, etc. shall terminate with a utility box with a faceplate with CAT5 connector.

### **3.5 CLASS 1 WIRING**

- .1 120 V circuits shall be, at a minimum, of #12 AWG RW-90 copper. For runs over 50 m in length, use #10 AWG RW-90 copper.

- .2 All wiring and power supplies to be copper conductor and be installed in EMT conduit.
- .3 Provide 120 V power supplies to all main DDC panels and interface device, separately circuited from all other loads.
- .4 Several Application Specific Controllers may be supplied from one 120 V power supply through a 120/24V transformer in accordance with the manufacturer's design. Only Application Specific Controllers connected to the same Building Controller may be connected to a common power supply.

### **3.6 CLASS 2 WIRING**

- .1 24 VAC power to controllers shall be separated from field devices transformer.
- .2 All wiring shall be copper conductors and be installed in EMT conduit.
- .3 Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
  - .1 Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
  - .2 All cables shall be UL listed for application, i.e. cables used in ceiling plenums shall be UL listed specifically for that purpose.
- .4 Any existing wiring considered for re-use (i.e. thermostat wiring re-use for temperature sensor) must be fully tested and verified prior to connection to new system. Any wiring deemed to not meet the project requirements must be replaced at the cost of the contractor.
- .5 Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- .6 Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.
- .7 All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block.
- .8 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

### **3.7 INSTALLATION OF SENSORS**

- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Mount sensors rigidly and adequate for the environment within which the sensor operates.
- .3 All wiring to sensors shall be in EMT conduit.
- .4 All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- .5 Sensors used in mixing plenums shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct with each bend supported with a capillary clip.

- .6 Immersion temperature sensors shall be installed in such a manner to allow the sensing element to be truly indicative of the medium temperature. Sensors shall be installed in wells with heat conducting compound and fastened into the well with fittings designed for the purpose.
- .7 Supply approved thermal wells of the appropriate size and type for sensing water temperatures, as required in the Points List, to the mechanical contractor for installation.
- .8 Strap-on type sensors shall be installed with thermal conducting compound and stainless steel band clamp.
- .9 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- .10 Install outdoor air temperature sensors on north wall complete with sun shield at designated location.
- .11 Duct static pressure sensing tip shall be located so as to properly sense the static pressure in the duct without being adversely affected by changes in flow from duct fittings. Locate sensing tip a minimum straight duct length of 6 duct diameters upstream and 4 duct diameters downstream from any duct takeoff or elbow fittings.
- .12 Wiring for space sensors shall be concealed in building walls. EMT conduit is acceptable within mechanical and service rooms.
- .13 All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- .14 Install labels on the inside covers of all room sensors identifying the point name using peel and stick labels such as the Brother labelling system.

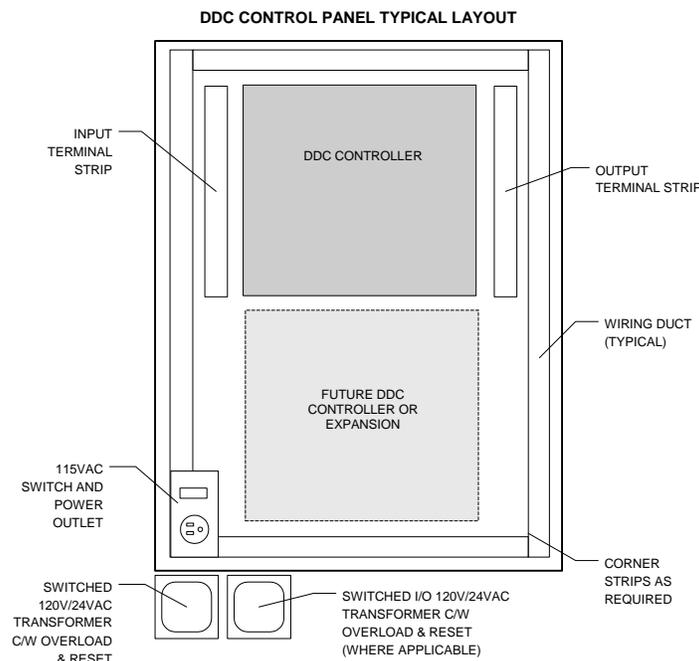
### **3.8 INSTALLATION OF RELAYS**

- .1 Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.
- .2 All relays to be tagged indicating DDC controller, point and function. All plug-in relays shall be labeled such that removal of the component does not remove the label.

### **3.9 INSTALLATION OF CONTROLLERS**

- .1 Equipment controllers shall be mounted inside enameled steel, fully enclosed NEMA 1 construction control cabinets with hinged door, key-lock latch, and removable sub-panels. A single key shall be common to all field panels and sub-panels.
- .2 Controllers and devices shall be conveniently spaced and neatly wired. Cables shall be accommodated inside slotted plastic wiring duct (Panduit or equivalent).
- .3 Input and output point wiring shall have an extra length of 50cm (1.5ft) for future panel retrofit.
- .4 Panels shall have an additional 20% free face area space to accommodate additional control devices.

- .5 Provide a separate Controller for each major piece of HVAC equipment. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- .6 All points associated with a single zone or an individual system shall be connected to the same controller. Points used for control loop reset such as outside air or space temperature are exempt from this requirement.
- .7 The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to independently operate under control.
- .8 Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.



- .9 Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional Controller boards or point modules shall be required to implement use of these spare points.
- .10 Building Controllers shall have the I/O points powered from a separate transformer to maintain the sub-network communications over an I/O device short circuit.

### **3.10 CONTROL PANELS**

- .1 Control panels shall be installed in accessible locations for ease of service.
- .2 Panels mounted inside mechanical rooms and other wall mount locations shall be mounted at 1.5m from floor.

- .3 Control panels mounted above dropped ceilings shall be located in corridors provided the resulting average wire length is less than 10m.
- .4 Control panels shall not obstruct service access to equipment.
- .5 A copy of the related as-built systems schematics, points list, and sequences of operation shall be placed inside each control panel. Points list shall be laminated and affixed inside the control panel door.

### **3.11 WARNING LABELS**

- .1 Affix plastic labels on each starter and equipment automatically controlled through the Control System. Label shall indicate the following:

<p>C A U T I O N This equipment is operating under automatic control and may start at any time without warning.</p>
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### **3.12 IDENTIFICATION OF HARDWARE AND WIRING**

- .1 All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information. Cable identifier shall be shown on and match record documents.
- .2 Permanently label or code each point of field terminal strips to show the instrument or item served.
- .3 Identify control panels with minimum 1 cm letters on laminated plastic nameplates.
- .4 Identify all other control components including control relays with permanent labels. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.
- .5 Where new points are added or where controllers are replaced, all cabling, wiring, and device tags shall be updated, as required and as built drawings shall be issued.
- .6 All new equipment shall be identified and tagged for entry into CMMS database according to instructions to be provided by Brookfield.

### **3.13 CONCEALED DEVICES IDENTIFICATION**

- .1 Identification shall be used to indicate the location of VAV boxes and concealed devices.
- .2 Identification shall be accordingly to existing code

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 01 11 00 – Summary of Work.
- .2      Section 01 33 00 - Submittal Procedures.
- .3      Section 01 78 00 - Closeout Submittals.
- .4      Section 25 05 01 – ECMS General Requirements

**1.2                COMMUNICATIONS**

- .1      The data communication protocol for the project shall comprise a BACnet inter-network. The Building Controller components shall meet ASHRAE / ANSI Standard 135-2008, BACnet - A Data Communication Protocol for Building Automation and Control Networks
- .2      Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device as defined in Section 25 30 01.
- .3      The communication between the Building Controllers (B-BC), and Advanced Application Controllers (B-AAC) / Application Specific Controllers (B-ASC) shall be via BACnet MS/TP networks. Arcnet, Lon or other protocols are not acceptable.
- .4      All BACnet MS/TP networks shall communicate error free at a baud rate of 76,800 bps.
- .5      Low capacitance cable with less than 15 Pico farads per foot shall be provided for MS/TP networks to for stable and less network communication errors.
- .6      The Controls Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the inter-network.
- .7      All Building Controllers shall have a communications port for connection with operator interfaces. This may be either an RS-232 port for Point to Point connection or a network interface node.
- .8      Communications services over the inter-network shall result in operator interface and value passing that is transparent to the inter-network architecture as follows:
  - .1      Connection of an operator interface device to any one controller on the inter-network will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the inter-network.
  - .2      All database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on the inter-network. This value passing shall be automatically performed by a controller when a reference to a point name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communications services to perform inter-network value passing.
  - .3      The time clocks in all controllers shall be automatically synchronized daily.

- .4 The Ethernet network shall be extended to all supervisory controllers, operator workstation and data server.
- .5 Networks connecting zone level controllers such as heat pumps, re-heat systems, etc. shall be directly connected to the DDC controller controlling the associated air handling unit.

### **1.3 INFORMATION ACCESS PROTOCOL**

- .1 The EMCS system shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.9, respectively, of ASHRAE Standard 135-2008, to communicate with BACnet objects in the internetwork.

### **1.4 INPUT/OUTPUT INTERFACE**

- .1 Hardwired inputs and outputs may tie into the system through Building, Custom, Application Specific Controllers or Lighting Controllers.
- .2 All input points and output points shall be protected such that shorting of the point to itself, another point, or ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.
- .3 Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices.
- .4 Pulse accumulation input points. This type of point shall conform to all the requirements of Binary Input points, and also accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.
- .5 Analog inputs shall allow the monitoring of low voltage (0-10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
- .6 Binary outputs shall provide for on/off operation, or a pulsed low voltage signal for pulse width modulation control. Binary outputs on Custom and Building Controllers shall have 3-position (on/off/auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
- .7 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0-10 Vdc or a 4-20 ma signal as required to provide proper control of the output device. Analog outputs on building or custom programmable controllers shall have status lights and a 2-position (auto/manual) switch and manually adjustable potentiometer for manual override.
- .8 Occupant adjustment of space temperature setpoint at network thermostats shall be limited to  $\pm 1.5^{\circ}\text{C}$  of nominal value unless otherwise specified.

### **1.5 SYSTEM GRAPHICS**

- .1 An operator with the proper password level shall be able to add, delete, or change dynamic points on a graphic. Dynamic points shall include analog and binary values, dynamic text,

static text, and animation files. Graphics shall have the ability to show animation of equipment.

.2 Graphic screens:

- .1 Graphic screens shall be created for main menu, weekly / holiday schedules, network schematic, floor plans, and for each system schematic or equipment as applicable.
- .2 Main Menu shall display general information of the building and the DDC system. From the main menu navigation buttons should direct to each floor, to main HVAC systems such as heat pump systems and hot water plants, and to the scheduling and network schematic screens.
- .3 Scheduling graphic screen shall be created to allow the building operator to access and adjust all weekly schedules set for the building (by floor, zone, tenant, etc), Annual (Holiday) Calendar, and Exception Schedule.
- .4 Floor plan graphics screens shall be created and reflect correct zoning such as areas served by air handling units. The zone numbers shall be the same as the equipment tag numbers. Floor graphic screen shall include zone temperatures, setpoints and links to equipment serving the floor. Where a modulating valve serves a zone the valve commanded position shall also be shown
- .5 Graphic screens shall be created for each piece of equipment such as air handling units, fan coils, boilers, etc displaying all associated inputs/outputs/setpoints.
- .6 A table with the heating valve operation shall be indicated in the associated heat pump unit system schematic. Table shall contain space temperature and damper position.
- .7 Building Network Diagram graphic screen shall be provided showing each controller and network panel complete with tag, address, controller make and model and installed location.

.3 Screen Navigation:

- .1 A menu bar shall be located at the bottom of each graphics screen. The menu bar and menu buttons shall be placed at exactly the same location on each graphic screen to allow browsing through the system by clicking on the buttons without moving the mouse.

MAIN MENU: Clicking the Main Menu button, in the left most position on the menu bar on all graphic screens, shall open the main menu graphic screen;

PREVIOUS: Clicking the Previous button, the second from the left position on the menu bar on all graphic screens, shall open the graphic screen most recently displayed prior to the currently graphic;

CUSTOM: One or more buttons for commands specific to the currently displayed graphic screen;

HELP: Clicking the Help button, located on the right most position of the menu bar on all graphic screens, shall open the help graphic screen;

- .2 A key plan shall be provided in the lower right hand corner with each graphic screen showing the related floor area plus the number of floors or levels. The shaded area will depict the area served by the graphic. Clicking on the level or floor number will

present the corresponding location on that floor graphic. Clicking on the non-shaded areas will present the graphic representing that area on the same floor.

.4 Minimum Requirements:

- .1 Placement of any information or active icons close to the edge of the graphic display area shall be avoided to minimize issues when sizing windows or screen setup with monitors with various resolutions.
- .2 The graphic title shall be located at the top of each screen. The outdoor air temperature shall be displayed at the top left corner of each graphics screen;
- .3 Text in graphic screens should have adequate font size for visualization and pleasing color contrast between lettering and background. Where text size precludes uncluttered placement of all information on the graphic screen, an additional zoom graphic screen shall be provided;
- .4 Point values or status shall be located as close as possible to the graphical representation of the actual physical location. If the point has an associated setpoint this point will be located directly below the actual point and be in a different colour;
- .5 Status of equipment shall be displayed as ON or OFF and located on top of commanded points; Command points shall be defined as Start/Stop or Enable/Disable, etc, but not as ON/OFF;
- .6 Operator overrides of input points or values or outputs normally under program control shall result in display an override (hand or red block) indication adjacent to the display;
- .7 Weekly schedules shall symbolized by a clock icon and be accessed from each system schematic graphic screen;
- .8 All specified multiple trends shall be accessible from the associated graphic screen, labelled and have the same placement on similar graphic screens;
- .9 Runtime hour icons shall be placed as close as possible to the actual point or value being totalized. The icon shall provide access to the totalizer configuration data.

.5 Colour Selection:

- .1 The visual impact of color shall align with the importance of the information.
  - .1 Bright red or yellow block with black letters shall be used for alarm and warning information;
  - .2 White block with black letters shall be used for dynamic information such as temperature and status;
  - .3 Light blue block shall be used for adjustable setpoints;
  - .4 Colour consistency shall be maintained throughout - all air systems similar, all hot water lines the same colour, all chilled water lines the same colour; return lines colour should be shown in a lower grade than the supply line.
  - .5 Colour selections shall provide legible gray scale outputs on printers.

- .6 Output Scaling:
  - .1 Information on position of 3-state (incremental) actuators should be displayed as open percentage and not as a position of each binary output (OPEN: ON/OFF; CLOSE: ON/OFF)
  - .2 All analog output values for control of pneumatically actuated valves and dampers shall be scaled and limited to 0 to 100% open for display on graphic screens.
- .7 Variables
  - .1 All variables specified as adjustable or configurable shall be configured as BACnet Analog Value objects. Adjustable shall signify that the object present value is displayed and can be modified on graphic screens whereas configurable signifies that the object present value can only be modified from within the object properties definition.
  - .2 All variables specified as fixed shall be imbedded in control programs and shall not be configured as BACnet objects.
- .8 Trending:
  - .1 System schematic graphic screens shall have as many trend /multi-trend icons as required in the specification linked to the specific trend graphic screen. Trend icons should have explanatory title and be placed on left upper corner of the screen.
- .9 Graphic screens shall be submitted to Prism for review prior to installation on the workstation. Final graphic screens shall be reviewed and accepted by Brookfield Maintenance Team Leader.

## **1.6 ENGINEERING UNITS**

- .1 Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system. Unit selection shall be able to be customized by locality to select the desired units for each measurement. Engineering units on this project shall be SI

## **1.7 POINT NAMING CONVENTION**

- .1 System names as points, variables, trends, schedule, calendar and other names shall be modular in design, allowing easy operator interface without the use of a written point index.
- .2 Point naming shall be composed as follows:

SITE\_BLDG\_SYS\_POINT\_FUNC

Where:

SITE is the site identifier

BLDG is an optional building identifier (applied where applicable)

SYS is the system identifier

POINT is the point identifier(s)

FUNC is the point function

**1.8 PROGRAMMING**

- .1 Provide programming for the system as per specifications and adhere to the control sequences provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- .2 All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.
- .3 Create and name all points indicated in the points lists. Software points (variable) shall have the same characteristics on the graphic screens as the real or hardware points. A few additional points may be required to comply with the intent of the generic logic, depending on the vendors system.
- .4 System point names as point, variable, trend, schedule, calendar and other names shall be modular in design, allowing easy operator interface without the use of a written point index.
- .5 Provide programming for the system as per specifications and adhere to the control sequences provided. All other system programming necessary for the operation of the system but not specified in this document shall also be provided by the Control System Contractor.
- .6 Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- .7 Provide a description for each analog and binary variable created. The description property shall include application and scope of the variable.
- .8 All variables specified as adjustable or configurable shall be configured as BACnet Analog Value objects. Adjustable shall signify that the object present value is displayed and can be modified on graphic screens whereas configurable signifies that the object present value can only be modified from within the object properties definition.
- .9 All variables specified as fixed shall be imbedded in control programs and shall not be configured as BACnet objects
- .10 The term “proven” (i.e. “proven on”/ “proven off”) shall mean that the equipment’s DI status point matches the state set by the equipment’s DO command point.
- .11 Where fan status is determined based on current measurement, a threshold shall be established to indicate belt failure.

**1.9 SCHEDULING AND OPTIMAL START**

- .1 Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member.

- .2 Each schedule shall consist of the following:
  - .1 Daily Schedule: Provide hourly scheduling blocks that allow multiple schedules during each day.
  - .3 Weekly Schedule: Provide separate schedules for each day of the week.
  - .4 Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
  - .5 Holiday Schedules: Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
  - .6 Optimal Start/Stop: The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than 24 hours. Provide the ability to modify the start/stop algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

## **1.10 CONTROL LOOPS**

- .1 A PI (proportional-integral) algorithms with direct/reverse action, anti-wind-up and deadband as applicable shall be supplied. The algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs. The controlled variable, setpoint, PI gains and deadband shall be user-selectable. The setpoint shall optionally be chosen to be a reset schedule.
- .2 Provisions shall be made to ensure that systems perform an orderly start-up without excessive temperatures, flows, pressures etc.
- .3 Unless otherwise indicated, control loops shall be enabled and disabled based on the status of the system being controlled to prevent wind-up or shall be forced to a condition which applies minimum control effect.
- .4 Unless specifically indicated otherwise:
  - ) Proportional only (P) loops shall be used for limiting loops (such as mixed air low limit control loops, minimum evaporator flow, etc.).
  - ) Derivative terms shall not be used unless proven to be required during field tuning.
- .5 Separate gains shall be used for each device where control is effected by staging multiple devices utilizing a single output (split range control). Gains shall be determined by the Contractor to provide stable control. If this is not possible, the operating range of each device shall be adjusted to provide stable control.
- .6 All control loops shall be tuned to provide stable and responsive control.

**1.11 STAGGERED START**

- .1 This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started; along with the time delay between starts shall be user-selectable.

**1.12 ALARMS AND ALARM REPORTING**

- .1 Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.
- .2 The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, be logged in the event log, printed, generate custom messages graphics.
- .3 Each binary object shall be set to alarm based on the operator specified state. Provide the capability to disable alarming when the associated equipment is turned off or is being serviced.
- .4 Each analog object shall have both high and low alarm limits and warning limits. Alarming must be able to be automatically and manually disabled.
- .5 Adequate range, time delay and interlocks shall be provided to avoid nuisance alarms caused by changes of state or normal temperature recovery period.
- .6 The alarm message shall be clear and provide enough information for the operator to determine the action to be taken in the event of an alarm. It shall include the name of the calling location, the device that generated the alarm, and the alarm message itself.
- .7 The operator shall be able to view all logged system alarms and events from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All alarms that have not been cleared by the operator shall be archived to the hard disk on the workstation.

**1.13 TREND LOGS**

- .1 The operator shall be able to define a custom trend log for any data in the system. This definition shall include interval, type of collection (polling or COV), start-time, and stop-time. Trend data shall be sampled and stored on the Building Controller panel and be archived on the hard disk.
- .2 Trend data shall be able to be viewed and printed from the operator interface software. They shall also be storable in a tab delimited ASCII format and able to be exported for use by other industry standard word processing and spreadsheet packages.
- .3 Trend Log Object and Trend Log Multiple Object Types shall be as defined in Clauses 12.25 and 12.30, respectively, of ASHRAE Standard 135-2008.
- .4 Trend axis shall be labeled with applicable units. Variable shall be assigned to an axis based on expected range and/or units.
- .5 Trends logs shall be configured as per section 25 90 01 – EMCS Systems Sequences of Operation for each I/O point for 300 samples at 15-minute intervals.

**1.14            OVERRIDDEN POINTS REPORT**

- .1        Overridden Points Report shall be created and available for the operator use

**Part 2            Products**

- 2.1        Not Used

**Part 3            Execution**

- 3.1        Not Used

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 11 00 - Summary of Work.
- .2        Section 01 77 00 - Closeout Submittals.
- .3        Section 25 05 01 - ECMS General Requirements

**Part 2            Products**

**2.1                WEB SERVER (B-OWS)**

- .1        The Controls Contractor shall provide a Web server able to access all information in the system.
- .2        The Web Server shall provide password protected Internet access from any computer and tablet such as iPad using web browsers such as Internet Explorer, Chrome, iPad/iPhone Safari, and Firefox. All graphic screens shall reside in the Web Server.
- .3        The Web Server shall reside on the same high-speed network as the building controllers.
- .4        Provide and install router / switches / modem and associated cables as required for remote communication to the building control system via Internet.
- .5        Access to the DDC system shall be provided by the DDC contractor via new dedicated internet connection. One year contract with an internet provider shall be included in this contract.
- .6        Contractor shall provide a local PC based operator workstation able to access all information in the DDC system. The operator workstation shall be installed in the DFO, Cultus Lake Laboratory and reside on the same Ethernet network as the building controllers.
- .7        Operator workstation shall be as appropriated for the DDC system and meet the following minimum hardware requirements:
  - .1        2.0 GHz or higher processor;
  - .2        RAM – Min. 4 GB;
  - .3        Hard Drive – 500 GB, 7200 rpm SATA;
  - .4        Video Card – On-Board min 1 GB;
  - .5        Network Card – Ethernet (802.3) 100/1000 Mb/sec;
  - .6        A minimum of 2 front and 2 rear access USB ports;
  - .7        DVD RW ROM drive;
  - .8        Monitor – 19” LCD ViewSonic, or equivalent Samsung or Dell;
  - .9        Keyboard – Standard 105-key Windows keyboard;
  - .10      Mouse – Logitech or Microsoft optical and pad;
  - .11      All necessary connection cables;
  - .12      Microsoft Windows operating system with license.

## **2.2 CONTROLLERS**

- .1 The following requirements shall apply to Building Controllers (B-BC), Advanced Application Controllers (B-AAC) and Application Specific Controllers (B-ASC):
- .2 Controllers shall be native BACnet. No translation software shall be used internal to the controller to convert from a proprietary protocol to BACnet Standard Object Types, Standard Application Services and Devices. Gateways are not native BACnet.
- .3 Effective Panel Processing Speed - Maximum permissible execution time is half a second. Execution time is defined as the time it takes the controller to execute all application software from some point in the software back to the same point while simultaneously responding to operator or terminal display requests and carrying out normal inter-panel communications. Set up an analog variable counter in each panel, incremented and reset by program code, to allow for verification of the processing speed.
- .4 Controllers shall have sufficient memory to support its operating system, database, programming and trending requirements. There shall be a minimum of 50% available memory free for future use.
- .5 Controllers shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- .6 Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
- .7 Controller operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m.
- .8 Provide diagnostic LEDs for power, communications, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- .9 Controller hardware shall be suitable for the anticipated ambient conditions.
- .10 Controllers used in conditioned ambient shall be mounted in NEMA 1 Type rated enclosures, and shall be rated for operation at 0°C to 50°C.
- .11 Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 Type waterproof enclosures, and shall be rated for operation at -40°C to 65°C.
- .12 Controllers that perform scheduling shall have a real time clock.

## **2.3 BUILDING CONTROLLERS**

- .1 The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Building Controllers to manage the global control strategies specified in the Sequences of Operation section of the Specifications
- .2 Each Building Controller shall reside on a BACnet inter-network using the ISO 8802-3 (Ethernet) Physical/Data Link layer protocol. Each Building Controller shall also perform routing to a network of Advanced Application and Application Specific Controllers.
- .3 The Building Controller shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-2004, to communicate with BACnet objects in the inter-network.

- .4 The controller shall provide a communications port for connection of the Portable Operators Terminal using Point-to-Point BACnet physical/data link layer protocol or a connection to the inter-network.
- .5 The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
- .6 Data shall be shared between networked Building Controllers on a peer-to-peer basis.
- .7 The Building Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
  - .1 assume a predetermined failure mode;
  - .2 generate an alarm notification.
- .8 The building controllers shall be able to communicate with and download programs to Application Specific Controllers.

**2.4 ADVANCED APPLICATION CONTROLLERS**

- .1 Advanced Application Controllers shall perform the control strategies specified in the Sequences of Operation section of the Specifications. Each of these panels shall meet the requirements as outlined in this section.
- .2 The Building Automation System shall be composed of one or more independent, stand-alone, microprocessor based Advanced Application Controllers to manage the local strategies described in System software section.
- .3 Controllers that perform scheduling shall have a real time clock.
- .4 The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
- .5 Data shall be shared between networked Controllers.
- .6 The Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
  - .1 assume a predetermined failure mode;
  - .2 generate an alarm notification.
- .7 The Advanced Application Controller shall communicate with other BACnet devices on the inter-network using the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-95.
- .8 Each controller shall reside on a BACnet network using a MS/TP Data Link/Physical layer protocol.
- .9 The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol to a portable operator's terminal.

**Part 3            Execution**

**3.1                Not used**

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 01 11 00 – Summary of Work.
- .2      Section 01 77 00 - Closeout Submittals.
- .3      Section 25 05 01 – ECMS General Requirements

**Part 2            Products**

**2.1                CONTROL DAMPERS**

- .1      Provide control damper as follows:
  - .1      Control Dampers shall be parallel or opposed blade type as scheduled on drawings and shall be constructed as described in this section.
  - .2      Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.
  - .3      Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.
  - .4      Damper shaft bearings shall be as recommended by manufacturer for application.
  - .5      All blade edges, top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.
  - .6      All leakage testing and pressure ratings will be based on AMCA Publication 500.
  - .7      Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

**2.2                ELECTRONIC DAMPER/VALVE ACTUATORS (DAx/VAx)**

- .1      Provide damper/valve actuators as follows:
  - .1      The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
  - .2      Where shown or specified, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
  - .3      All rotary spring return actuators shall be capable of both clockwise and counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
  - .4      Proportional actuators shall accept a 0-10 VDC or 0-20 mA control signal and provide a 2-10 VDC or 4-20 mA operating range.

- .5 All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
- .6 All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation
- .7 Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
- .8 Actuators shall be Underwriters Laboratories Standard 873 listed.
- .9 Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.
- .10 Actuators shall allow smooth operation throughout entire operating range and assure tight shut-off against system pressure.
- .11 Provide position indicators on volume control dampers.
- .12 Actuators shall remain stationary until the applied signal changes.

### **2.3 TEMPERATURE SENSORS**

- .1 Provide one of the following temperature sensor types throughout:
  - .1 10,000 Ohm at 25°C thermister
  - .2 1000 Ohm at 0°C ( $\pm 0.2$  ohm) thin film platinum with coefficient of resistivity of 0.000385 ohms/ohm/°C
  - .3 100 Ohm at 0°C ( $\pm 0.2$  ohm) platinum with coefficient of resistivity of 0.00385 ohms/ohm/°C
- .2 Sensors shall have an accuracy of  $\pm 0.3$  C or better.
- .3 All temperature sensors provided shall be constructed in a strain minimizing construction with integral anchored lead wires

### **2.4 DUCT MOUNTED TEMPERATURE SENSORS - (TSD2)**

- .1 Provide general purpose duct mount temperature sensors as follows:
  - .1 Copper sheathed construction
  - .2 Standard conduit box termination, complete with screw terminal connector block
  - .3 Length to extend, at minimum, one-third of the distance across the duct

### **2.5 OUTSIDE AIR TEMPERATURE SENSORS (TSO)**

- .1 Provide outside air temperature sensors as follows:
  - .1 weather proof enclosure complete with on-corroding outdoor shield designed to minimize the effect of solar heating on the sensing element;
  - .2 threaded fittings for mating to 12 mm conduit or as applicable;

- .3 total probe length of 50 mm;
- .4 stainless steel sheath;
- .5 operating range: -35°C to +50°C.

## **2.6 ROOM TEMPERATURE SENSORS (TSR/TSR1/TSR2/TSR3)**

- .1 Provide room temperature sensors as follows:
  - .1 For non-security applications (TSR/TSR2/TSR3) the sensing element shall be installed in a vented wall mounted protective enclosure.
  - .2 For security applications (TSR1) the sensing element shall be attached directly to a rigid, metal cover plate designed for mounting into a recessed junction box.
  - .3 Equipped with set-point adjustment, override switch, display, and/or communication port as shown on points list.

## **2.7 CONTROL RELAYS (CR1, 2 & 3, CRS)**

- .1 Provide control relays as follows:
  - .1 Control relays shall be UL listed plug-in type with dust cover. Contact rating, configuration, and coil voltage suitable for application.
  - .2 Provide NEMA 1 Type enclosure when not installed in local control panel.
  - .3 Electro mechanical relays shall have integral override switch to allow local override in event of DDC control failure.
  - .4 Motor rated relays shall be provided in DDC enable control application for small motors (pumps, fans, etc) equipped with manual starters.
  - .5 Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from set-point shown on plans. Contact rating, configuration, and coil voltage suitable for application.

## **2.8 CURRENT TRANSDUCERS (CS1)**

- .1 Provide current transducers as follows:
  - .1 range selected to match the current of the application;
  - .2 output to match the requirements of the DDC System;
  - .3 accuracy of  $\pm 2\%$  full scale or better;
  - .4 repeatability of  $\pm 2\%$  full scale or better;
  - .5 over-current and over-voltage protection as applicable;
  - .6 shock and vibration protection as necessary.

## **2.9 TRANSFORMERS AND POWER SUPPLIES**

- .1 Provide control relays as follows:

- .1 Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with over-current protection in both primary and secondary circuits for Class 2 service.
- .2 Unit shall operate between 0°C and 50°C.
- .3 Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Unit shall have built-in over-voltage protection.
- .4 A single transformer limited to a Class 2 (100VA) transformer could be used to power several VAV box controllers. Transformers shall be located inside the air handling unit mechanical room.

**2.10 FIELD DEVICE TYPES**

- .1 Field devices, specifications shall be based on the following device types as noted in points lists and/or drawings.

**Table 1: Control Device Types**

<b>Device Type</b>	<b>Description</b>	<b>Technical Performance</b>	<b>Notes</b>
CR2	Control relay (Dry contact electro-mechanical relay)	240V / 10A rated to suit application	IDEC - RH Series Carlo Gavazzi - RCP8 Functional Devices RIB Series
CR3	Power relay (Dry contact electro-mechanical relay)	240V / Amps rated to suit application.	Normally closed contact
CS1	Current Transducer		Greystone CS-450. Enercorp Sentry 100
DA1/ VA1	Damper Actuator (Electric, modulating, non-spring-return)	Power Voltage 24 VAC or 120 VAC Control Voltage 0-10 VDC DC brushless motor with overload protection Use the required number of actuators to provide enough torque to control the existing damper	Belimo GMB-24SR; AMB-24SR; HMB-24SR; LMB-24SR
DA2/ VA2	Damper Actuator (Electric, modulating, spring return)	Power voltage 24 VAC or 120 VAC Control Voltage 0 - 10 VDC DC brushless motor with overload protection	Belimo AF24-MFT-US; NF24-MFT-US; LF24-MFT-US
TSD	Duct temperature sensor	Length to extend, at minimum, one-third of the distance across the duct	Greystone TE-200-B Enercorp TS-D Delta DTS-400
TSO	Outside air temperature		Greystone TE200-F / FE

<b>Device Type</b>	<b>Description</b>	<b>Technical Performance</b>	<b>Notes</b>
	sensor		Enercorp TS-O
TSR	Room temperature sensor		Greystone TE200-AE Enercorp TS-S-E
TSR2	Room temperature sensor, security type.		Greystone TE200-AS Enercorp TS-PL
TSR3	Room temperature sensor complete with momentary override switch, setpoint adjustment, and setpoint indication.		Greystone TE200-AE-x-AP-BS-AC Delta Intellistat RTS406

**Part 3 Execution**

3.1 Install sensors and devices in accordance with manufacturer's recommendations.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.
- .2      Section 01 77 00 - Closeout Submittals.

**1.2                CLOSEOUT SUBMITTALS**

- .1      Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**Part 2            PRODUCTS**

- 1.3      The control points listed in the Points List represent the minimum number of control points. The Contractor shall provide additional control points and control devices as required to achieve the specified sequences of control. See Point List on the following pages.

**1. DDC POINTS LIST**

Provide the following Control Points

Point	Label	Point Description	Device	Comments
IP1	CLL_OAT	HP-1 & 2 Outdoor Temperature Sensor	TSO	
IP2	CLL_MAT	HP-1 Mixed Air Temperature	TSD	
IP3	CLL_HP1_SAT	HP-1 Supply Air Temperature	TSD	
IP4	CLL_HP1_RAT	HP-1& 2 Return Air Temperature	TSD	
IP5	CLL_HP1_SFS	HP-1 Supply Fan Status	CS1	
IP6	CLL_HP1_OD	HP-1 Outdoor Unit Status	CS1	
IP7-11	CLL_Rxx_T	HP-1 Room xx Temperatures	TSR3	Five (5) sensors, locations as indicated on drawings
IP12	CLL_HP2_SAT	HP-2 Supply Air Temperature	TSD	
IP13	CLL_MAT	HP-2 Mixed Air Temperature	TSD	
IP14	CLL_HP2_SAT	HP-2 Return Air Temperature	TSD	
IP15	CLL_HP2_SFS	HP-2 Supply Fan Status	CS1	
IP16	CLL_HP2_OD	HP-2 Outdoor Unit Status	CS1	
IP17-21	CLL_Ryy_T	HP-2 Room yy Temperatures	TSR3	Five (5) sensors, locations as indicated on drawings
IP22	CLL_EF101_SFS	EF-101 Fan Status	CS1	
IP23	CLL_FH1_SFS	Fume Hood #1 Fan Status	CS1	
IP24	CLL_FH2_SFS	Fume Hood #2 Fan Status	CS1	
IP25	CLL_FH3_SFS	Fume Hood #3 Fan Status	CS1	
IP26	CLL_BLR_BST	Boiler Status	CS1	
IP27	CLL_P1_PST	Primary Boiler Pump 1 Status	CS1	
IP28	CLL_P2_PST	Secondary Boiler Pump 2 Status	CS1	
IP29	CLL_HWS_T	Boiler Hot Water Supply Temp	TS	Strap On Sensor
IP30	CLL_HWR_T	Boiler Hot Water Return Temp	TS	Strap On Sensor
OP1	CLL_CD1A_OA	CD-1A OA Damper control	DA2	
OP2	CLL_CD1B_RA	CD-1A RA Damper control	DA2	
OP3	CLL_CD1C_RLF	CD-1A Relief Damper control	DA2	
OP4	CLL_HP1_SFC	HP-1 Supply Fan Command	CR2	
OP5	CLL_HP1_CLG1_C	HP-1 Cooling Command Stage 1	CR2	

Point	Label	Point Description	Device	Comments
OP6	CLL_HP1_CLG2_C	HP-1 Cooling Command Stage 2	CR2	
OP7	CLL_HP1_HTG1_C	HP-1 Heating Command Stage 1	CR2	
OP7	CLL_HP1_HTG2_C	HP-1 Heating Command Stage 2	CR2	
OP7	CLL_RH1_HTC	HP-1 Reheat Coil Heating Command	VA1	Control Existing Valve
OP8	CLL_RH1_PC	HP-1 Reheat Coil Circ Pump Command	CR2	Control Existing Pump
OP9	CLL_CD2A_OA	CD-2A OA Damper control	DA2	
OP10	CLL_CD1B_RA	CD-2A RA Damper control	DA2	
OP11	CLL_HP1_SFC	HP-2 Supply Fan Command	CR2	
OP12	CLL_HP1_CLG_C	HP-2 Cooling Command	CR2	Stage 1 Control
OP13	CLL_HP1_CLG_C	HP-2 Cooling Command	CR2	Stage 2 Control
OP14	CLL_HP1_HTG1_C	HP-2 Heating Command	CR2	
OP15	CLL_RH1_HTC	HP-2 Reheat Coil Heating Command	VA1	Control Existing Valve
OP16	CLL_RH1_PC	HP-2 Reheat Coil Circ Pump Command	CR2	Control Existing Pump
OP17	CLL_BLR_C	Boiler Enable Command	CR2	
OP18	CLL_P1_C	Pump P-1 Enable Command	CR2	
OP19	CLL_P2_C	Pump P-2 Enable Command	CR2	
OP20	CLL_BB1_C	Baseboard Zone 1 Control Command	VA2	
OP21	CLL_BB2_C	Baseboard Zone 2 Control Command	VA2	
OP22	CLL_BB3_C	Baseboard Zone 3 Control Command	VA2	
OP23	CLL_BB4_C	Baseboard Zone 4 Control Command	VA2	

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 01 11 00 – Summary of Work.
- .2      Section 01 77 00 - Closeout Submittals.
- .3      Section 25 05 01 – ECMS General Requirements
- .4      Section 25 30 03 Points List

**Part 2            Products**

**1.2                NOT USED**

**Part 3            Execution**

**1.3                CONTROL SEQUENCES**

**.1                 Heat Pump Units (HPO-1 & HPI-1), Exhaust Fan (EF-101) and Reheat Coil (HC-1) Control**

.1      General

Heat pump system 1 (HPO-1 and HPI-1) serves the Lab room and offices located at the front of the building.

Room temperature sensors shall be provided with setpoint adjustment and occupancy override button.

The DDC system shall interface via relays with the existing hot water baseboard heaters and reheat coil to modulate the baseboard heaters and reheat coil in sequence with the heat pump.

When Fume Hood #3 is operating, HP-1 shall operate as per occupied hours with the minimum outdoor air damper position shall be 40% outdoor air. When Fume Hood #3 is not operating, the minimum outdoor air damper position shall be 20% outdoor air and EF-101 shall operate continuously during occupied hours and shall be off during unoccupied hours.

The heat pump shall be used to provide the first stage of heating. If the heat pump cannot meet the heating load, the reheat coil shall be used to provide the second stage of heating. Hot water baseboard heaters shall provide the third stage of heating and be used to provide “top up” heating in specific zones as required. Multiple temperature sensors are to be averaged to minimize the offset between room temperatures and room temperature setpoints.

Economizer control shall be used as the first stage of cooling and the heat pump compressor shall be used to provide the second stage of cooling. Economizer shall be enabled when the outdoor air temperature is 2°C below the return air temperature and disabled when the outdoor air is equal to the return air temperature.

.2 Start-up:

The heat pump units shall operate during occupied hours based on weekly schedules subject to the global holiday calendar.

Once the supply fan operation is confirmed the outdoor air damper shall ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be generated. On a supply fan failure alarm, the outdoor air damper shall close.

.3 Morning Warm-up Mode / Optimum Start:

The system shall incorporate an optimum start heating and cooling routine that will start the unit at the latest possible time to have the space at the occupied temperature setpoint at the start of occupancy.

The outdoor air damper shall be fully closed during the warm-up period, unless Fume Hood #3 is operating.

.4 Occupied Mode:

The supply fan shall run continuously during occupied periods.

The cooling demand shall be based on the maximum zone temperature high variance calculated as the lesser of the number of degrees by which one or more of the space temperatures exceeds the space temperature setpoint and the number of degrees by which the space temperatures exceed the zone temperature high limit set at 22.5°C (adjustable on controls screen). Similarly the heating demand shall be calculated based on the zone temperature low limit of 20.5°C (adjustable on control screen).

Note: This method ensures that a high variance will exist only when zone temperature is above (or below for heating) both the space temperature setpoint and the zone temperature high limit (low limit for heating).

On a call for cooling from any space and the economizer is enabled, the DDC system shall modulate the outdoor air damper to maintain a cooling demand at zero.

The heat pump shall start in cooling mode subject to a 5-minute minimum off time when the cooling demand exceeds 1.5°C (adjustable). The compressor shall stop when the cooling demand is zero.

The heat pump shall start in heating mode subject to a 5-minute minimum off time when the heating demand exceeds 1.5°C (adjustable). The compressor shall stop when the heating demand is zero.

A 15 minutes delay shall be implemented when switching between heating and cooling modes.

During occupied periods the electric baseboard heaters shall be enabled to be controlled by its integral thermostat.

.5 Relief and Mixing Damper Control:

The relief damper shall be controlled by the associated outdoor air dampers.

The DDC system shall monitor the two heat pump outdoor air dampers and fume hood status and modulate the damper (open or close) between a minimum and a maximum damper position setpoints as required to maintain a slight positive building pressure. When Fume Hood #3 is operating, the minimum outdoor air position shall be 40% outdoor air when Fume Hood #3 is not operating, the minimum outdoor air position shall be 25% outdoor air.

When both HPI-1 and HP-2 are both bringing in more than 60% outdoor air (average OA damper position, setpoint to be adjustable on controls screen), the relief air opening (CD-1C) shall modulate between 25% open and 100% open, as the average outdoor air intake (average OA damper positions) for HPI-1 and HPI-2 vary between 60% and 100% outdoor air.

Mixing dampers shall modulate in sequence with the heat pump and reheat coil to maintain the room temperature set points. Minimum ventilation rates and associated damper positions shall be determined by a balancing contractor to deliver the specified minimum outdoor air quantity.

.6 Unoccupied Mode:

During unoccupied mode the supply fan shall be off, the outdoor air damper closed, and the baseboard heaters disabled.

The DDC system shall enable the hot water baseboards when any space temperature decrease below the unoccupied temperature setpoint of 16°C and disable the baseboards at 2°C differential (setpoints to be adjustable on control screen).

If the space temperature in any space served by the heat pump unit drops 2°C below the unoccupied temperature setpoint, the unit shall start in full recirculation mode. The heat pump unit shall stop when the space temperature reaches the unoccupied temperature setpoint.

The auxiliary reheat coil heating shall be enabled if the compressor was enable in heating mode for more than 10 minutes and the zone temperature decreases 3°C below the occupied temperature setpoint, or if the outdoor temperature is below 0°C (adjustable on control screen)

.7 Alarms

Provide the following alarms:

<b>Alarm</b>	<b>Alarm Source</b>	<b>High Limit</b>	<b>Low Limit</b>
Space Temp Extreme	RT Sensor	SP + 3°C	SP - 3°C
Supply Temp Extreme	SAT Sensor	50°C	5°C
Low M/A Temp	MAT Sensor	-	< 4°C
Supply Fan failure	Fan Motor Status		
Cooling failure (*)	Supply Temp	RMT - 4°C	-
Heating Failure (**)	Supply Temp	RMT + 4°C	-

(\*) Cooling failure alarm shall be generated if the heat pump has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4°C below the room temperature.

(\*\*) Heating failure alarm shall be generated if the heat pump has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4°C above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

.8 System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

Zone damper position, minimum and maximum damper position setpoints, and room temperature/setpoint shall be indicated in the floor plans. Provide a graphic screen with a table showing all zone damper positions, room temperatures and setpoints along with the associated heat pump unit supply air temperature.

.9 Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

Point	Trend Type
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Outdoor Damper Command	Polling
Cooling Command	Polling
Heating Command	Polling
Auxiliary Heating Command	Polling
Supply Fan Status	Polling
Exhaust Fan Status	Polling
Fume Hood Fan Status	Polling

Trend 2:

Point	Trend Type
HP-1 Supply Air Temperature	Polling
Zone/Room Temperatures	Polling
HP-1 Damper Commands	Polling

.10 Run Time Logs

Run time totalizers shall be provided as follows:

Supply Fan Status
Exhaust Fan Status
Cooling Command
Heating Command
Auxiliary Heating Command

Totalizers shall be reset on an annual basis or by command by the building operator.

## **.2 Heat Pump Unit 2 (HPI-2 & HPO-2) and Reheat Coil (HC-2) Control**

### **.1 General**

Heat pump system 2 (HPO-2 and HPI-2) serves the Lab room and offices located at the back of the building.

Room temperature sensors shall be provided with setpoint adjustment and occupancy override button.

The DDC system shall interface via relays with the existing hot water baseboard heaters and reheat coil to modulate the baseboard heaters and reheat coil in sequence with the heat pump.

When either (or both) of the Fume Hoods (#1 or #2) are operating, HP-2 shall operate as per occupied hours and the minimum outdoor air damper position shall be 50% outdoor air. When neither Fume Hood is operating, the minimum outdoor air damper position shall be 25% outdoor air during unoccupied hours.

The heat pump shall be used to provide the first stage of heating. If the heat pump cannot meet the heating load, the reheat coil shall be used to provide the second stage of heating. Hot water baseboard heaters shall provide the third stage of heating and be used to provide "top up" heating in specific zones as required. Multiple temperature sensors are to be averaged to minimize the offset between room temperatures and room temperature setpoints.

Economizer control shall be used as the first stage of cooling and the heat pump compressor shall be used to provide the second stage of heating. When the outdoor air temperature is more than 1.5°C higher than the average indoor temperature, the heat pump shall revert to minimum outdoor air.

### **.2 Start-up:**

The heat pump units shall operate during occupied hours based on weekly schedules subject to the global holiday calendar.

Once the supply fan operation is confirmed the outdoor air damper shall ramp to its minimum position.

If proper operation is not established after a timed delay an alarm shall be generated. On a supply fan failure alarm, the outdoor air damper shall close.

### **.3 Morning Warm-up Mode / Optimum Start:**

The system shall incorporate an optimum start heating and cooling routine that will start the unit at the latest possible time to have the space at the occupied temperature setpoint at the start of occupancy.

The outdoor air damper shall be fully closed during the warm-up period, unless Fume Hood #1 and/or Fume Hood #2 are operating.

.4 Occupied Mode:

The supply fan shall run continuously during occupied periods.

The cooling demand shall be based on the maximum zone temperature high variance calculated as the lesser of the number of degrees by which one or more of the space temperatures exceeds the space temperature setpoint and the number of degrees by which the space temperatures exceed the zone temperature high limit set at 22.5°C (adjustable on controls screen). Similarly the heating demand shall be calculated based on the zone temperature low limit of 20.5°C (adjustable on control screen).

Note: This method ensures that a high variance will exist only when zone temperature is above (or below for heating) both the space temperature setpoint and the zone temperature high limit (low limit for heating).

On a call for cooling from any space and the economizer is enabled, the DDC system shall modulate the outdoor air damper to maintain a cooling demand at zero.

The heat pump shall start in cooling mode subject to a 5-minute minimum off time when the cooling demand exceeds 1.5°C (adjustable). The compressor shall stop when the cooling demand is zero.

The heat pump shall start in heating mode subject to a 5-minute minimum off time when the heating demand exceeds 1.5°C (adjustable). The compressor shall stop when the heating demand is zero.

A 15 minutes delay shall be implemented when switching between heating and cooling modes.

.5 Relief and Mixing Damper Control:

The relief damper shall be controlled by the associated outdoor air dampers.

The DDC system shall monitor the two heat pump outdoor air dampers and fume hood status for Fume Hoods (#1 and #2) and modulate the relief air damper (open or closed) between a minimum and a maximum damper positions as required to maintain a slight positive building pressure. When Fume Hood #1 and/or Fume Hood #2 are operating, the minimum outdoor air position for HP-2 shall be 50% outdoor air. When neither Fume Hood is operating, the minimum outdoor air position shall be 25% outdoor air.

When both HPI-1 and HP-2 are bringing in more than 60% (average) outdoor air (adjustable on controls screen), the relief air opening (CD-1C) shall modulate between 25% open and 100% open, as the average outdoor air intake (average OA damper positions) for HPI-1 and HPI-1 vary between 60% and 100% outdoor air.

Mixing dampers shall modulate in sequence with the heat pump and reheat coil to maintain the room temperature set points. Minimum ventilation rates and

associated damper positions shall be determined by a balancing contractor to deliver the specified minimum outdoor air quantity.

.6 Unoccupied Mode:

During unoccupied mode the supply fan shall be off, the outdoor air damper closed, and the baseboard heaters disabled.

The DDC system shall enable the baseboards when any space temperature decrease below the unoccupied temperature setpoint of 16°C and disable the baseboards at 2°C differential (adjustable on control screen).

If the space temperature in any space served by the heat pump unit drops 2°C below the unoccupied temperature setpoint, the unit shall start in full recirculation mode. The heat pump unit shall stop when the space temperature reaches the unoccupied temperature setpoint.

The auxiliary reheat coil heating shall be enabled if the compressor was enabled in heating mode for more than 10 minutes and the zone temperature decreases 3°C below the occupied temperature setpoint, or if the outdoor temperature is below 0°C (adjustable on control screen)

.7 Alarms

Provide the following alarms:

<b>Alarm</b>	<b>Alarm Source</b>	<b>High Limit</b>	<b>Low Limit</b>
Space Temp Extreme	RT Sensor	SP + 3°C	SP - 3°C
Supply Temp Extreme	SAT Sensor	50°C	5°C
Low M/A Temp	MAT Sensor	-	< 4°C
Supply Fan failure	Fan Motor Status		
Cooling failure (*)	Supply Temp	RMT - 4°C	-
Heating Failure (**)	Supply Temp	RMT + 4°C	-

(\*) Cooling failure alarm shall be generated if the heat pump has been operating in cooling mode for a period of 10 minutes continuous and the discharge air temperature is greater than 4°C below the room temperature.

(\*\*) Heating failure alarm shall be generated if the heat pump has been operating in heating mode for a period of 10 minutes continuous and the discharge air temperature is less than 4°C above the room temperature.

Applicable interlocks as well as adequate time delay shall be provided to avoid nuisance alarms caused by changes of state as well normal temperature recovery period.

.8 System Graphics

System graphic screen shall indicate the complete equipment layout with all inputs, outputs, setpoints, and alarms. Provide navigation buttons to main menu, associated trends and associated screens. All setpoints shall be adjustable at graphic screen.

Zone damper position, minimum and maximum damper position setpoints, and room temperature/setpoint shall be indicated in the floor plans. Provide a graphic

screen with a table showing all zone damper positions, room temperatures and setpoints along with the associated heat pump unit supply air temperature.

.9 Trends

Provide 300 sample trends, at 15-minute intervals as applicable, for the following points/variables:

Trend 1:

<b>Point</b>	<b>Trend Type</b>
Outdoor Air Temperature	Polling
Mixed Air Temperature	Polling
Supply Air Temperature	Polling
Outdoor Damper Command	Polling
Cooling Command	Polling
Heating Command	Polling
Auxiliary Heating Command	Polling
Supply Fan Status	Polling
Exhaust Fan Status	Polling
Fume Hood #1 Fan Status	Polling
Fume Hood #2 Fan Status	Polling

Trend 2:

<b>Point</b>	<b>Trend Type</b>
HP-2 Supply Air Temperature	Polling
Zone/Room Temperatures	Polling
HP-2 Damper Commands	Polling

.10 Run Time Logs

Run time totalizers shall be provided as follows:

Supply Fan Status
Fume Hood Fan Status
Cooling Command
Heating Command
Auxiliary Heating Command

Totalizers shall be reset on an annual basis or by command by the building operator.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1      Canadian Standards Association (CSA International)
  - .1      CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
  - .2      CSA C22.2
  - .3      CAN/CSA-C22.3 No. 1-01(current version), Overhead Systems.
- .2      Institute of Electrical and Electronics Engineers (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1      IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

**1.2                DEFINITIONS**

- .1      Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

**1.3                SCOPE OF WORK**

- .1      Disconnect and reconnect power wiring from existing air conditioning units.
- .2      Provide power wiring for new, split system heat pumps HP-1 and HP-2 (indoor and outdoor).
- .3      Provide relays, junction boxes and wiring as required at the electrical panels to isolate the baseboard heaters at night, where indicated on the drawings.
- .4      Provide wiring from existing electrical panel to supply fan EF-101.
- .5      Provide power supply for new DDC controls system.
- .6      Provide labelling and colour coded identification for cables, conduits and fittings.

**1.4                REGULATORY REQUIREMENTS**

- .1      Execution of all Work shall be performed to comply with and conform to requirements of the 2012 Canadian Electrical Code C22.1-12 (or current version), 2012 BC Building Code (or current version), 2010 National Building Code (or current version), 2010 National Fire Code (or current version) and all applicable provincial, city, municipal and / or district bylaws and to the satisfaction of authorities having jurisdiction of the place of Work.
- .2      Where requirements detailed in these specifications exceed code requirements or are more stringent than code requirements, the specification requirements shall take precedence and shall be adhered to.

- .3 In the event of a conflict between code requirements and those detailed in these specifications, the former shall prevail. Note that requirements within the specification that are more stringent requirements than codes do not constitute a conflict.

## **1.5 DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

## **1.6 QUALITY ASSURANCE**

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold a valid Master Electrical Contractor license or are employed by such an entity. Apprentices may conduct Work under the supervision of a journeyman electrician in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

## **Part 2 Products**

### **2.1 STANDARD OF MATERIALS**

- .1 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.
- .2 Materials required for performance of work to be new and the best of their respective kinds and of uniform pattern throughout work.
- .3 Materials to be of Canadian manufacture where obtainable. Materials of foreign manufacture, unless specified are to be approved before being ordered. Products are to be purchased through manufacturer's Canadian Distributors or Wholesalers, or directly from the manufacturer, when obtainable.
- .4 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Section, before such items are purchased.
- .5 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.
- .6 Where requirements of this Specification exceed those of applicable standards, this Specification governs.

## **2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls.

## **2.3 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction.
- .2 Decal signs, minimum size 175 x 250 mm.

## **2.4 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.
- .2 Apply anti-oxidization compounds as required for connections made between dissimilar metals.

## **2.5 EQUIPMENT IDENTIFICATION**

- .1 Labels for feeder conduits, cables to indicate their content are to comprise pressure sensitive tape. Print labels on plastic coated tape, 50.8 mm x 152.4 mm (2" x 6") size with black printing on yellow background indicating applicable voltage, i.e. 600 volts.
- .2 Label feeder conduits, cables.
- .3 Locate labels as follows:
  - .1 At every end of every conduit, or cable run, adjacent to item of equipment serviced.
  - .2 On each exposed conduit, duct or cable passing through a wall, partition or floor (one on each side of such wall, partition or floor).
  - .3 At every access point on concealed conduit or cable.
- .4 Labels are to be visible from 5'-0" (1524 mm) above adjacent floor or platform.
- .5 Labels and colour coding shall meet the following DFO standards.

## **2.6 WIRING IDENTIFICATION**

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.
- .5 Labels and colour coding shall meet the following DFO standards: use 25 mm wide, prime colour and 20 mm wide auxiliary colour plastic tape or paint to label conduits, boxes and cables on each side of wall penetrations and at intervals of 10 meters:

- ) 250 Volts and below; Prime-Yellow, Auxiliary- none;
- ) Up to 600 V; Prime-Yellow, Auxiliary- Green;
- ) Telephone; Prime-Green, Auxiliary- none;
- ) Other communications, Prime- Green, Auxiliary- Blue;
- ) Fire Alarm; Prime-Red, Auxiliary- none;
- ) Emergency Voice;, Prime- Red, Auxiliary- Blue;
- ) Direct Digital Control; Prime-Purple, Auxiliary- none;

**2.7 FUSES**

- .1 Fuses to conform to CSA Standard C22.2 No. 106-1953 or CSA Standard C22.2 No. 106-M1985.
- .2 Fuse interrupting rating to be 200,000 A RMS symmetrical.
- .3 Fuses are to be sized as shown.
- .4 Fuses rated to 600 A are to be CSA certified HRCI-J/Class J time delay.
- .5 Fuses rated 601 A and larger to be CSA certified HRC-L/Class L.
- .6 Provide a complete set of fuses in each fusible device supplied under this Division.
- .7 Provide a spare set of three fuses of each size and type supplied and hand over to Owner at completion of work.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

- .2 Provide new breakers sized for new equipment in existing panelboards. Provide modifications to bus work to ensure proper connection and mounting.
- .3 Relocate any lighting as required that is obstructing new equipment installations so to avoid the new equipment and provide even illumination of the area.

### **3.2 NAMEPLATES AND LABELS**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed. Update panel schedules.

### **3.3 MOUNTING HEIGHTS**

- .1 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

### **3.4 CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

### **3.5 CLEANING**

- .1 Refer to 01 74 11 - CLEANING
- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1            Section 26 05 00 – Common Work Results for Electrical.

**1.2                PRODUCT DATA**

- .1            CSA C22.2 No. 0.3-09 Test Methods for Electrical Wires and Cables.

**1.3                DELIVERY, STORAGE AND HANDLING**

- .1            Packaging Waste Management: remove for reuse and recycle.

**Part 2            Products**

**2.1                CONDUCTORS, WIRES AND CABLES**

- .1            All conductors are to be copper conductors. All AWG sizes given in this specification refer to the copper AWG size.
- .2            All conductors to be in EMT conduit.
- .3            Wiring installed in conduit, unless otherwise noted, to be 600 volt RW-90 X-Link.
- .4            Use copper wiring, minimum No. 12 gauge for lighting and power wiring. Size wires for 2% maximum voltage drop to farthest outlet on a loaded circuit.

**2.2                TECK 90 CABLE**

- .1            Teck cable shall only be allowed for short flexible connections to accommodate vibration and equipment serving.
  - .2            Cable: in accordance with Section 26 05 00 – Common Work Results for Electrical.
  - .3            Conductors:
    - .1            Grounding conductor: copper as indicated.
    - .2            Circuit conductors: copper as indicated, size as indicated.
  - .4            Insulation:
    - .1            Ethylene propylene rubberEP.
    - .2            Cross-linked polyethylene XLPE.
    - .3            Rating: 600 V.
  - .5            Inner jacket: polyvinyl chloride material.
  - .6            Armour: aluminum.
  - .7            Overall covering: compliant to applicable Building Code classification for this project.
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- .8 Fastenings:
  - .1 One hole straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
  - .2 Channel type supports for two or more cables at 1200 mm centers.
  - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .9 Connectors:
  - .1 Watertight, approved for TECK cable.

### **2.3 ARMOURED CABLES**

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel strip.
- .4 Type: PVC jacket over armour and compliant to applicable Building Code classification for this project.
- .5 Connectors: anti short connectors.

## **Part 3 Execution**

### **3.1 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Perform tests using method appropriate to site conditions and to approval of Owner's Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

### **3.2 WIRING METHODS**

- .1 Install wiring in conduit unless otherwise specified.
- .2 Use thin wall conduit for branch circuit and signal wiring in ceilings, and furred spaces. Use rigid galvanized steel conduit for wiring in poured concrete, or where conduit could be exposed to mechanical injury.
- .3 Conduit is to be of sufficient size to permit easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced. Do not bend conduit over sharp objects. Improperly formed bends and running threads will not be accepted. Do not use bends and fittings together.
- .4 Run conduits and cables in finished areas concealed, above finished ceilings, under floors, in walls and in partitions. Run conduit and cables in unfinished areas, such as fan rooms and penthouses, exposed and install at right angles or parallel to building lines, accurate in line and level.
- .5 Runs of conduit and cables, where shown are indicated only by general location and routing. Install conduits and cables to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass. Install as close to building structure as possible, so that, where concealed, necessary furring can be kept to a

minimum. Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.

- .6 Wiring and conduit for wall devices etc., to be routed in ceiling space of floor they are serving.
- .7 Install conduit and cables to avoid proximity to water and heating pipes. They are not be run within 152.4 mm (6") of such pipes except where crossings are unavoidable, in which case they are to be kept at least 25 mm (1") from covering of pipe crossed.
- .8 Provide expansion joint sleeves with ground jumpers in conduit runs where they cross building expansion joints.
- .9 Provide new wires in conduit for all new equipment shown on drawings.

### **3.3 GROUNDING**

- .1 Ground electrical equipment and wiring in accordance with Canadian Electrical Code and Local Inspection Authority's Rules and Regulations.
- .2 Condition or existence of grounding of existing luminaires must be reviewed and proper grounding confirmed. Inform Consultant if ungrounded luminaires or service feeder to luminaires are identified.

### **3.4 CONDUCTORS, WIRES AND CABLES**

- .1 Colour code all conductors. Conductors No. 2 gauge and smaller to have colour impregnated into insulation at time of manufacture. Conductors size larger than No. 2 gauge may be colour coded with adhesive colour coding tape but only black insulated conductors are to be employed in this case, except for neutrals which are to be white whenever possible. Conductors of No. 8 gauge and larger must be stranded.

- .2 Colour code as follows:

Phase "A"	Red	Ground	Green
Phase "B"	Black	Neutral	White
Phase "C"	Blue	Control	Orange

- .3 Neutral conductors may be identified by a coloured insulation with three or more extruded longitudinal white stripes along the insulation, and will be deemed to have a white or natural covering. All neutral conductors used in the Work must match building standard.
- .4 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.
- .5 Splice wire, up to and including No. 6 gauge, with twist-on style connections rated minimum 600 volts (1000 volts in luminaires). Connection body to be moulded of thermoplastic. Spring insert to have an expandable square-edge. Splice large conductors using split-bolt or compression type connections wrapped with PVC tape.
- .6 Where colour coding tape is utilized, it is to be applied for a minimum of 50.8 mm (2") at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any circumstances. Colour coding also applies to bussing in panels.

### **3.5 EQUIPMENT AND WIRING TESTING**

- .1 Make tests of equipment and wiring at time requested.

- .2 Tests are to include measured insulation values, voltage and current readings to determine balance of panels and feeders under full load, and operation of each piece of equipment for correct operation.
- .3 Supply meters, materials and personnel as required, to carry out these tests.
- .4 Test electrical work to standards and function of Specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.
- .5 Where specialized equipment or controls systems requiring commissioning are installed as part of Work, arrange and pay for services of manufacturer's factory service engineer / technician to supervise initial start-up or calibration of such equipment or controls. Engineer / technician shall check systems installation and verify operation is correct or shall adjust, balance and calibrate components, or direct installer to perform these tasks, including installation related wiring and operation of controls, to the satisfaction of the engineer / technician and the Consultant.
- .6 Instruct Owner's operating personnel in the operation of the installations. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of installation in complete working order, and to ensure that Owner's operating personnel are fully conversant with every aspect of the operation, care and maintenance thereof.

### **3.6 GENERAL CABLE INSTALLATION**

- .1 Cable Colour Coding: to Section 26 05 00 – Common Work Results for Electrical.
- .2 Conductor length for parallel feeders to be identical.
- .3 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .4 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .5 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.

### **3.7 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Canadian Electrical Code

### **3.8 INSTALLATION OF TECK90 CABLE (0 -1000 V)**

- .1 Group cables wherever possible on channels.
- .2 Install cable concealed, securely supported by straps or hangers.

### **3.9 INSTALLATION OF ARMOURED CABLES**

- .1 Group cables wherever possible on channels.

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**END OF SECTION**