Public Works and Government Services Canada

Requisition Number: **EZ899-170983/A**

SPECIFICATIONS for:

Pacific Forestry Centre 506 West Burnside Road
Victoria, BC

(i) Greenhouse Energy Management System

Project Number: **R.076293.001**

(ii) APPROVED BY:

Regional Manager, AES — Date: 2016-07-14.

Construction Safety Coordinator — Date: 2016-07-14

(iii) TENDER:

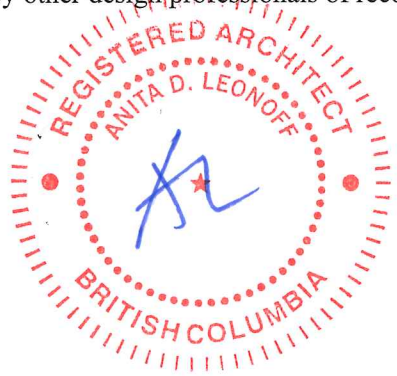
Project Manager — Date: 2016-07-14

1.1 DESIGN PROFESSIONALS OF RECORD

.1 Architect

.1 IBI Group, ~~Tony Gill~~ Anita Leonoff

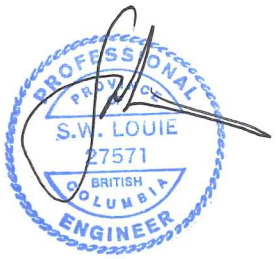
.2 Responsible for Divisions 01-44 as applicable to the project, except where indicated as prepared by other design professionals of record.



.2 Mechanical Engineer

.1 MCW Consultants Ltd., Sam Louie

.2 Responsible for Divisions 20 through 23 as applicable to the project.



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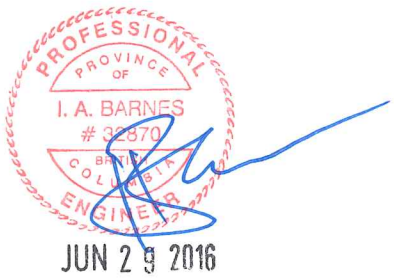
.3 Electrical Engineer

.1 AES Engineering Ltd., Iain Barnes

.2 Responsible for Divisions 26 as applicable to the project.



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END OF SECTION

END OF SECTION

Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises an energy management upgrade to the existing Greenhouse controls system, sensors, ridge and sidewall vent systems, zone heating systems, shade and blackout screening systems, and upgrades to fire and life safety signage and exiting.

AIP2PAC-NRCAN Pacific Forestry Centre

Greenhouse Energy Management System

Project: R.076293.001

1.2 CONTRACT METHOD

.1 Construct Work under Lump Sum Contract.

1.3 SCHEDULE

.1 Complete all required systems and controls design (in consultation with the Departmental Representative) within three (3) weeks of award of Contract. Allow for one intermediate design review with Departmental Representative at the midpoint of this period – to be included in construction schedule.

.1 Contractor to coordinate items requiring long lead times and place orders for such items accordingly to coincide with appropriate phases and not be the cause of delays.

.2 Allow one (1) week for Departmental Representative to conduct final review and provide approval of the designs.

.3 Allow three (3) weeks of construction per phase.

.4 Allow one (1) week between phases for component testing/verification/commissioning and Owner items to be relocated.

.5 The construction schedule should reflect the following suggested outline schedule:

	Weeks																
Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Systems and Controls Design	●	●	●														
Client Review/Approval Period				●													
Phase 1 Work					●	●	●										
Phase 1 Verification/Testing/Cx and contents relocation								●									
Phase 2 Work									●	●	●						
Phase 2 Verification/Testing/Cx and contents relocation												●					
Phase 3 Work													●	●	●		
Phase 3 and Final Verification/Testing/Cx																●	
Substantial Completion																	●

1.4 CONTRACTOR USE OF PREMISES

.1 Limit use of premises for Work to allow:

.1 Owner occupancy

.2 Co-ordinate use of premises under direction of Departmental Representative.

.1 Normal hours of operation: Monday through Friday – 08:00 to 16:30.

.2 Any work required to be conducted outside of normal hours of operation are to be scheduled with the approval of the Departmental Representative. Notifications of such work are to be provided minimum 5 days in advance of the work.

.3 The Contractor will be responsible for co-ordinating the phasing schedule, work, and requirements with Departmental Representative and provide provisions for any requirements including, but not limited to, temporary heating, lighting, and ventilation.

.4 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

.5 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.

.6 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.

.7 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

1.5 OWNER OCCUPANCY

.1 Owner will occupy premises during the Work of this Contract for execution of normal operations. Existing experiments within the Greenhouse are required to be ongoing and construction work is to be conducted in such a manner as to cause minimal disturbances. Contractor is to propose phasing of the work in consultation with the Departmental representative to maintain operational compartments and minimize disruptions to allow researchers ongoing access to relevant Greenhouse compartments.

.2 Maintain access to all available exits throughout construction.

.3 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.6 DOCUMENTS REQUIRED

.1 Maintain at job site, one copy of each document as follows:

.1 Contract Drawings.
.2 Specifications.
.3 Addenda.
.4 Reviewed Shop Drawings.
.5 List of Outstanding Shop Drawings.
.6 Change Orders.
.7 Other Modifications to Contract.
.8 Field Test Reports.
.9 Copy of Approved Work Schedule.
.10 Health and Safety Plan and Other Safety Related Documents.
.11 Other documents as specified.

PART 2 – PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 – EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACCESS AND EGRESS

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

1.2 USE OF SITE AND FACILITIES

.1 Execute Work with least possible interference or disturbance to normal use of premises.

.2 Make arrangements with Departmental Representative to facilitate Work as stated.

.3 Maintain existing services to building and provide for personnel and vehicle access.

.4 Contractor parking and access is to conform to A0.02 - Site Plan - Contractor Staging Diagram, unless otherwise approved by the Departmental Representative.

.5 Where security is reduced by Work provide temporary means to maintain security.

.6 All construction personnel access and materials deliveries will be through the South doors of the Greenhouse.

.1 Access into the Header House shall only be to conduct necessary Work and will not be used as a means to access the Greenhouse.

.7 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, occupants, public and normal use of premises. Notify and arrange in advance, minimum 48 hours, with Departmental Representative to facilitate the execution of any Work that may cause excessive noise and/or disruption of services during normal working hours to adjacent and neighboring facilities.

1.4 SPECIAL REQUIREMENTS

.1 Submit schedule in accordance with Section 01 32 16 - Construction Progress Schedule - Bar (GANTT) Chart.

.2 Means of Egress shall not be encumbered or blocked off.

.3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.

.4 Keep within limits of Work and avenues of ingress and egress.

.5 Ingress and egress of Contractor vehicles at site is limited to locations and times as instructed by Departmental Representative.

1.5 SECURITY

.1 Where security has been reduced by Work of Contract, provide temporary means to maintain security.

.2 Contractor’s Site Superintendent shall sign out a Contractor pass for each construction crew member at the start of the project. Wear pass visibly at all times while on property. Surrender pass to designated official at the end of the project. Replacement costs of $100 per pass shall be assessed against the Contractor for passes lost during the course of the project.

.3 Contractor's personnel shall be in possession of Government issued picture identification at all times while on property.

1.6 BUILDING SMOKING ENVIRONMENT

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

PART 2 – PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 – EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

.1 Schedule and administer project meetings throughout the progress of the work and at the call of Departmental Representative.

.2 Prepare agenda for meetings.

.3 Distribute written notice of each meeting four days in advance of meeting date to Departmental Representative.

.4 Provide physical space and make arrangements for meetings.

.5 Preside at meetings.

.6 Record meeting minutes. Include significant proceedings and decisions. Identify actions by parties.

.7 Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants and affected parties not in attendance.

.8 Representative of Contractor, subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 PRECONSTRUCTION MEETING

.1 Within 10 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.

.2 Representatives of Owner, Consultant, Contractor, major subcontractors, suppliers listed in bid form, field inspectors and supervisors will be in attendance.

.3 Coordinate time and location of meeting and notify parties concerned minimum 5 days before meeting.

.4 Agenda to include:

- .1 Appointment of official representative of participants in the Work.
- .2 Schedule of Work: in accordance with Construction Progress Schedules.
- .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
- .5 Delivery schedule of specified equipment.
- .6 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
- .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
- .8 Owner provided products and salvaged items as indicated on drawings.
- .9 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .10 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.

.12 Monthly progress claims, administrative procedures, photographs, hold backs.

.13 Appointment of inspection and testing agencies or firms.

.14 Insurances, transcript of policies.

1.3 PROGRESS MEETINGS

.1 During course of Work schedule progress meetings regularly once every two weeks.

.2 Contractor, major subcontractors involved in Work, Consultant, and Departmental Representative are to be in attendance.

.3 Notify parties minimum 5 days prior to meetings.

.4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 7 days after meeting.

.5 Agenda to include the following:

.1 Review, approval of minutes of previous meeting.

.2 Review of Work progress since previous meeting.

.3 Field observations, problems, conflicts.

.4 Problems which impede construction schedule.

.5 Review of off-site fabrication delivery schedules.

.6 Corrective measures and procedures to regain projected schedule.

.7 Revision to construction schedule.

.8 Progress schedule, during succeeding work period.

.9 Review submittal schedules: expedite as required.

.10 Maintenance of quality standards.

.11 Review proposed changes for effect on construction schedule and on completion date.

.12 Other business.

PART 2 – PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 – EXECUTION

3.1 Not Used

.1 Not Used.

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.

.3 Generally Bar Chart should be derived from commercially available computerized project management system.

.4 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.

.5 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.

.6 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.

.7 Master Plan: summary-level schedule that identifies major activities and key milestones.

.8 Milestone: significant event in project, usually completion of major deliverable.

.9 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.

.10 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.2 REQUIREMENTS

.1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.

.2 Plan to complete Work in accordance with prescribed milestones and time frame.

.3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.

.4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit to Departmental Representative within five 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 Departmental Representative within five working days of receipt of acceptance of Master Plan.

1.4 MASTER PLAN

.1 Structure schedule to allow orderly planning, organizing and execution of Work as Bar Chart (GANTT).

.2 Departmental Representative will review and return revised schedules within five working days.

.3 Revise impractical schedule and resubmit within five working days.

.4 Accepted revised schedule will become Master Plan and be used as baseline for updates.

1.5 PROJECT SCHEDULE

.1 Develop detailed Project Schedule developed to include period of Controls System Design and proposed phasing strategy.

.2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:

.1 Award.

.2 Shop Drawings, Samples.

.3 Controls System Design and Review Period.

.4 Permits.

.5 Mobilization.

.6 Demolition.

.7 Construction and Installation Phasing Periods.

.8 Substantial Completion.

1.6 PROJECT SCHEDULE REPORTING

.1 Update Project Schedule on weekly basis reflecting activity changes and completions, as well as activities in progress.

.2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

1.7 PROJECT MEETINGS

.1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.

.2 Weather related delays with their remedial measures will be discussed and negotiated.

PART 2 – PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 – EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

.1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work are coordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.

.10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Submit drawings stamped and signed by professional engineer registered or licensed in British Columbia.

.3 Submissions shall be electronic, readable in pdf format.

.4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.5 Allow seven (7) days for Departmental Representative's review of each submission.

.6 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.7 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in

writing of revisions other than those requested.

.8 Accompany submissions with transmittal letter, in duplicate, containing:

.1 Date.

.2 Project title and number.

.3 Contractor's name and address.

.4 Identification and quantity of each shop drawing, product data and sample.

.5 Other pertinent data.

.9 Submissions include:

.1 Date and revision dates.

.2 Project title and number.

.3 Name and address of:

.1 Subcontractor.

.2 Supplier.

.3 Manufacturer.

.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

.5 Details of appropriate portions of Work as applicable:

.1 Fabrication.

.2 Layout, showing dimensions, including identified field dimensions, and clearances.

.3 Setting or erection details.

.4 Capacities.

.5 Performance characteristics.

.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

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

.11 Submit of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

.12 Submit product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.

.13 Submit test reports for requirements requested in specification Sections and as requested by Departmental Representative.

.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

.2 Testing must have been within 3 years of date of contract award for project.

.14 Submit certificates for requirements requested in specification Sections and as requested

by Departmental Representative.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

.2 Certificates must be dated after award of project contract complete with project name.

.15 Submit manufacturer’s instructions for requirements requested in specification Sections and as requested by Departmental Representative.

.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.16 Submit Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.

.17 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.18 Submit Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.

.19 Delete information not applicable to project.

.20 Supplement standard information to provide details applicable to project.

.21 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, submissions will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.22 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

.23 Provide Material Safety Data Sheets (MSDS) for all products with toxicity warnings or containing products known to be hazardous to health.

1.3 SAMPLES

.1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to Departmental Representative's business address site office.

.3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

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

1.5 PHOTOGRAPHIC DOCUMENTATION

.1 Submit digital photography in jpg format, fine resolution as directed by Departmental Representative.

.2 Project identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 4 locations.

.4 Viewpoints and their location as determined by Departmental Representative.

.5 Frequency of photographic documentation: as directed by Departmental Representative.

1.6 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit WorkSafeBC 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 REFERENCES

.1 Government of Canada.

.1 Canada Labour Code - Part II

.2 Canada Occupational Health and Safety Regulations.

.2 National Building Code of Canada (NBC):

.1 Part 8, Safety Measures at Construction and Demolition Sites.

.3 The Canadian Electric Code (as amended).

.4 Canadian Standards Association (CSA) as amended:

.1 CSA S269.1-1975 (2003) Falsework for Construction Purposes.

.2 CSA Z797-2009, Code of Practice for Access Scaffold.

.3 CSA Z1006-10 Management of Work in Confined Spaces.

.4 CSA Z462 Workplace Electrical Safety Standard.

.5 National Fire Code of Canada 2010 (as amended)

.1 Part 5 – Hazardous Processes and Operations and Division B as applicable and required.

.6 American National Standards Institute (ANSI):

.1 ANSI A10.3 Operations – Safety Requirements for Powder-Actuated Fastening Systems.

.7 Fire Protection Engineering Services, HRSDC:

.1 FCC No. 301, Standard for Construction Operations.

.2 FCC No. 302, Standard for Welding and Cutting.

.8 Province of British Columbia:

.1 Workers Compensation Act Part 3 Occupational Health and Safety.

.2 Occupational Health and Safety Regulation

1.2 RELATED SECTIONS

.1 Refer to the following current NMS sections as required:

.1 Project meetings: Section [01 31 19]

.2 Construction progress schedules: Section [01 32 16]

.3 Submittals procedures: Section [01 33 00]

.4 Temporary utilities: Section [01 51 00]

.5 Construction facilities: Section [01 52 00]

.6 Temporary barriers and enclosures: Section [01 56 00]

1.3 WORKERS' COMPENSATION BOARD COVERAGE

.1 Comply fully with the Workers' Compensation Act, regulations and orders made pursuant thereto, and any amendments up to the completion of the work.

.2 Maintain Workers' Compensation Board coverage during the term of the Contract, until and including the date that the Certificate of Final Completion is issued.

1.4 COMPLIANCE WITH REGULATIONS

.1 PSPC may terminate the Contract without liability to PSPC where the Contractor, in the opinion of PWGSC, refuses to comply with a requirement of the Workers' Compensation Act or the Occupational Health and Safety Regulations.

.2 It is the Contractor's responsibility to ensure that all workers are qualified, competent and certified to perform the work as required by the Workers' Compensation Act or the Occupational Health and Safety Regulations.

1.5 SUBMITTALS

.1 Submit to Departmental Representative submittals listed for review. [in accordance with Section 013300].

.2 Submit the following:

.1 Site specific Health and Safety Plan.

.2 Copies of reports or directions issued by Federal and Provincial Health and Safety inspectors.

.3 Copies of incident and accident reports.

.4 Complete set of Material Safety Data Sheets (MSDS), and all other Documentation required by Workplace Hazardous Materials Information System (WHMIS) requirements.

.5 Emergency Procedures.

.1 The Departmental Representative will review the Contractor's site-specific project Health and Safety Plan and emergency procedures, and provide comments to the Contractor within [5] days after receipt of the plan. Revise the plan as appropriate and resubmit to Departmental Representative.

.2 Medical surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of work, and submit additional certifications for any new site personnel to Departmental Representative.

.3 Submission of the Health and Safety Plan, and any revised version, to the Departmental Representative is for information and reference purposes only. It shall not:

.1 Be construed to imply approval by the Departmental Representative.

.2 Be interpreted as a warranty of being complete, accurate and legislatively compliant.

.3 Relieve the Contractor of his legal obligations for the provision of health and safety on the project.

1.6 RESPONSIBILITY

.1 Assume responsibility as the Prime Contractor for work under this contract.

.2 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

.3 Comply with and enforce compliance by employees with safety requirements of Contract documents, applicable Federal, Provincial, Territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.7 HEALTH AND SAFETY COORDINATOR

.1 The Health and Safety Coordinator must:

.1 Be responsible for completing all health and safety training, and ensuring that personnel that do not successfully complete the required training are not permitted to enter the site to perform work.

.2 Be responsible for implementing, revising, daily enforcing, and monitoring the Site Specific Health and Safety Plan.

.3 Be on site during execution of work.

1.8 GENERAL CONDITIONS

.1 Provide safety barricades and lights around work site as required to provide a safe working environment for workers and protection for pedestrian and vehicular traffic.

.2 Ensure that non-authorized persons are not allowed to circulate in designated construction areas of the work site.

.1 Provide appropriate means by use of barricades, fences, warning signs, traffic control personnel, and temporary lighting as required.

.2 Secure site at night time [or provide security guard] as deemed necessary to protect site against entry.

1.9 PROJECT/SITE CONDITIONS

.1 Work at site will involve contact with:

.1 Multi-employer work site.

.2 Federal employees and general public.

.3 See Preliminary Hazard Assessment Form Appendix D

1.10 UTILITY CLEARANCES

.1 The Contractor is solely responsible for all utility detection and clearances prior to starting the work.

.2 The Contractor will not rely solely upon the Reference Drawings or other information provided for utility locations.

1.11 REGULATORY REQUIREMENTS

.1 Comply with specified codes, acts, bylaws, standards and regulations to ensure safe operations at site.

.2 In event of conflict between any provision of the above authorities, the most stringent provision will apply. Should a dispute arise in determining the most stringent requirement, the Departmental Representative will advise on the course of action to be followed.

1.12 WORK PERMITS

.1 Obtain specialty trade permit[s] related to project before start of work.

1.13 FILING OF NOTICE

.1 The General Contractor is to complete and submit a Notice of Project as required by Provincial authorities.

.2 Provide copies of all notices to the Departmental Representative.

1.14 HEALTH AND SAFETY PLAN

.1 Conduct a site-specific hazard assessment based on review of Contract documents, required work, and project site. Identify any known and potential health risks and safety hazards.

.2 Prepare and comply with a site-specific project Health and Safety Plan based on hazard assessment, including, but not limited to, the following:

.1 Primary requirements:

.1 Contractor's safety policy.
.2 Identification of applicable compliance obligations.
.3 Definition of responsibilities for project safety/organization chart for project.
.4 General safety rules for project.
.5 Job-specific safe work, procedures.
.6 Inspection policy and procedures.
.7 Incident reporting and investigation policy and procedures.
.8 Occupational Health and Safety Committee/Representative procedures.
.9 Occupational Health and Safety meetings.
.10 Occupational Health and Safety communications and record keeping procedures.

.2 Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations which must be performed as part of the work.

.3 List hazardous materials to be brought on site as required by work.

.4 Indicate engineering and administrative control measures to be implemented at the site or managing identified risks and hazards.

.5 Identify personal protective equipment (PPE) to be used by workers.

.6 Identify personnel and alternates responsible for site safety and health.

.7 Identify personnel training requirements and training plan, including site orientation for new workers.

.3 Develop the plan in collaboration with all subcontractors. Ensure that work/activities of subcontractors are included in the hazard assessment and are reflected in the plan.

.4 Revise and update Health and Safety Plan as required, and re-submit to the Departmental Representative.

.5 Departmental Representative's review: the review of Site Specific Health and Safety Plan by Public Service and Procurement Canada (PSPC) shall not relieve the Contractor of responsibility for errors or omissions in final Site Specific Health and Safety Plan or of responsibility for meeting all requirements of construction and Contract documents.

1.15 EMERGENCY PROCEDURES

.1 List standard operating procedures and measures to be taken in emergency situations. Include an evacuation plan and emergency contacts (i.e. names/telephone numbers) of:

.1 Designated personnel from own company.

.2 Regulatory agencies applicable to work and as per legislated regulations.

.3 Local emergency resources.

.4 Departmental Representative [site staff].

.2 Include the following provisions in the emergency procedures:

.1 Notify workers and the first-aid attendant, of the nature and location of the emergency.

.2 Evacuate all workers safely.

.3 Check and confirm the safe evacuation of all workers.

.4 Notify the fire department or other emergency responders.

.5 Notify adjacent workplaces or residences which may be affected if the risk extends beyond the workplace.

.6 Notify Departmental Representative [site staff].

.3 Provide written rescue/evacuation procedures as required for, but not limited to:

.1 Work at high angles.

.2 Work in confined spaces or where there is a risk of entrapment.

.3 Work with hazardous substances.

.4 Work on, over, under and adjacent to water.

.5 Workplaces where there are persons who require physical assistance to be moved.

.4 Design and mark emergency exit routes to provide quick and unimpeded exit.

1.16 HAZARDOUS PRODUCTS

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to the Departmental Representative and in accordance with the Canada Labour Code.

.2 Where use of hazardous and toxic products cannot be avoided:

.1 Advise Departmental Representative beforehand of the product(s) intended for use. Submit applicable MSDS & WHMIS documents as per Section 01 33 00.

.2 In conjunction with Departmental Representative, schedule to carry out work during "off hours" when tenants have left the building.

.3 Provide adequate means of ventilation in accordance with Section 01 51 00.

.4 The Contractor shall ensure that the product is applied as per manufacturers' recommendations.

.5 The Contractor shall ensure that only pre-approved products are brought onto the work site in an adequate quantity to complete the work.

1.17 ASBESTOS HAZARD

.1 Carry out any activities involving asbestos in accordance with applicable Provincial/Territorial Regulations.

.2 Discovery of asbestos are to be handled as indicated in Section 01 41 00.

1.18 PCB REMOVALS

.1 Mercury-containing fluorescent tubes and ballasts which contain polychlorinated biphenyls (PCBs) are classified as hazardous waste.

.2 Discovery of PCB's are to be handled as indicated in Section 01 41 00.

1.19 REMOVAL OF LEAD-CONTAINING PAINTS

.1 All paints containing TCLP lead concentrations above 5 ppm are classified as hazardous.

.2 Carry out demolition activities involving lead-containing paints in accordance with applicable Provincial/Territorial regulations.

1.20 ELECTRICAL SAFETY REQUIREMENTS

.1 Comply with authorities and ensure that, when installing new facilities or modifying existing facilities, all electrical personnel are completely familiar with existing and new electrical circuits and equipment and their operation.

.1 Before undertaking any work, coordinate required energizing and de-energizing of new and existing circuits with Departmental Representative.

.2 Maintain electrical safety procedures and take necessary precautions to ensure safety of all personnel working under this Contract, as well as safety of other

personnel on site.

1.21 ELECTRICAL LOCKOUT

.1 Develop, implement and enforce use of established procedures to provide electrical lockout and to ensure the health and safety of workers for every event where work must be done on any electrical circuit or facility.

.2 Prepare the lockout procedures in writing, listing step-by-step processes to be followed by workers, including how to prepare and issue the request/authorization form. Have procedures available for review upon request by the Departmental Representative.

.3 Keep the documents and lockout tags at the site and list in a log book for the full duration of the Contract. Upon request, make such data available for viewing by Departmental Representative or by any authorized safety representative.

1.22 OVERLOADING

.1 Ensure no part of work is subjected to a load which will endanger its safety or will cause permanent deformation.

1.23 1.23 FALSEWORK

.1 Design and construct falsework in accordance with CSA S269.1-1075 (R2003).

1.24 SCAFFOLDING

.1 Design, construct and maintain scaffolding in a rigid, secure and safe manner, in accordance with CSA Z797-2009 and B.C. Occupational Health and Safety Regulations.

1.25 CONFINED SPACES

.1 Carry out work in confined spaces in compliance with Provincial/Territorial regulations.

1.26 POWDER-ACTUATED DEVICES

.1 Use powder-actuated devices in accordance with ANSI A10.3 only after receipt of written permission from the Departmental Representative.

1.27 FIRE SAFETY AND HOT WORK

.1 Obtain Departmental Representative's authorization before any welding, cutting or any other hot work operations can be carried out on site.

.2 Hot work includes cutting/melting with use of torch, flame heating roofing kettles, or other open flame devices and grinding with equipment which produces sparks.

1.28 FIRE SAFETY REQUIREMENTS

.1 Store oily/paint-soaked rags, waste products, empty containers and materials

subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

.2 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

.3 Portable gas and diesel fuel tanks are not permitted on most Federal work sites. Approval from the Departmental Representative is required prior to any gas or diesel tank being brought onto the work site.

1.29 FIRE PROTECTION AND ALARM SYSTEM

.1 Fire protection and alarm systems shall not be:

.1 Obstructed.

.2 Shut off.

.3 Left inactive at the end of a working day or shift.

.2 Do not use fire hydrants, standpipes and hose systems for purposes other than firefighting.

.3 Be responsible/liable for costs incurred from the fire department, the building owner and the tenants, resulting from false alarms.

1.30 UNFORESEEN HAZARDS

.1 Should any unforeseen or peculiar safety-related factor, hazard or condition become evident during performance of the work, immediately stop work and advise the Departmental Representative verbally and in writing.

1.31 POSTED DOCUMENTS

.1 Post legible versions of the following documents on site:

.1 Site Specific Health and Safety Plan.

.2 Sequence of work.

.3 Emergency procedures.

.4 Site drawing showing project layout, locations of the first-aid station, evacuation route and marshalling station, and the emergency transportation provisions.

.5 Notice of Project.

.6 Floor plans or site plans.

.7 Notice as to where a copy of the Workers' Compensation Act and Regulations are available on the work site for review by employees and workers.

.8 Workplace Hazardous Materials Information System (WHMIS) documents.

.9 Material Safety Data Sheets (MSDS).

.10 List of names of Joint Health and Safety Committee members, or Health and Safety Representative, as applicable.

.2 Post all Material Safety Data Sheets (MSDS) on site, in a common area, visible to all workers and in locations accessible to tenants when work of this Contract includes construction activities adjacent to occupied areas.

.3 Postings should be protected from the weather, and visible from the street or the exterior of the principal construction site shelter provided for workers and equipment, or as approved by the Departmental Representative.

1.32 MEETINGS

.1 Attend health and safety pre-construction meeting and all subsequent meetings called by the Departmental Representative.

1.33 CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by the Departmental Representative.

.2 Provide Departmental Representative with written report of action taken to correct non-compliance with health and safety issues identified.

.3 The Departmental Representative may issue a "stop work order" if non-compliance of health and safety regulations is not corrected immediately or within posted time. The General Contractor/subcontractors will be responsible for any costs arising from such a "stop work order".

PART 2 – PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 – EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Definitions:

.1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humans; or degrade environment aesthetically, culturally and/or historically.

.2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

.2 Submit 2 copies of WHMIS MSDS.

.3 Before commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative.

.4 Environmental Protection Plan must include comprehensive overview of known or potential environmental issues to be addressed during construction.

.5 Address topics at level of detail commensurate with environmental issue and required construction tasks.

.6 Include in Environmental Protection Plan:

.1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.

.2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.

.3 Names and qualifications of persons responsible for training site personnel.

.4 Descriptions of environmental protection personnel training program.

.5 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use.

.1 Plan to include measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.

.6 Spill Control Plan to include procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.

.7 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

.8 Contaminant Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.

1.3 FIRES

.1 Fires and burning of rubbish on site is not permitted.

1.4 POLLUTION CONTROL

.1 Maintain temporary pollution control features installed under this Contract.

.2 Control emissions from equipment and plant in accordance with local authorities' emission requirements.

.3 Cover dry materials and rubbish to prevent blowing dust and debris.

1.5 NOTIFICATION

.1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.

.2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.

.1 Take action only after receipt of written approval by Departmental Representative.

.3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.

.4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Ensure public waterways, storm and sanitary sewers remain free of waste and volatile materials disposal.

.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.4 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES AND CODES

.1 Perform Work in accordance with National Building Code of Canada (NBC) and the British Columbia Building Code (BCBC) 2012 including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.

.2 Professional Consultants and Engineers shall be using Schedules as provided in the BCBC.

.3 Meet or exceed requirements of:

.1 Contract documents.

.2 Specified standards, codes and referenced documents.

1.2 HAZARDOUS MATERIAL DISCOVERY

.1 Asbestos: demolition of spray or trowel-applied asbestos is hazardous to health. Stop work immediately when material resembling spray or trowel-applied asbestos is encountered during demolition work. Notify Departmental Representative.

.2 Mould: stop work immediately when material resembling mould is encountered during demolition work. Notify Departmental Representative.

.3 PCB and lead-containing paints: stop work immediately when PCB's or lead paint encountered during demolition work. Notify Departmental Representative.

1.3 BUILDING SMOKING ENVIRONMENT

.1 Smoking is not permitted anywhere on the property.

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 INSPECTION

.1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.

.2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.

.3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.

.4 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Departmental Representative shall pay cost of examination and replacement.

1.2 PROCEDURES

.1 Notify Departmental Representative in advance of requirement for inspections in order that attendance arrangements can be made.

1.3 REJECTED WORK

.1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re- execute in accordance with Contract Documents.

.2 Make good other Contractor's work damaged by such removals or replacements promptly.

.3 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Departmental Representative.

1.4 REPORTS

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

.2 Provide copies to subcontractor of work being inspected or tested.

1.5 TESTS AND MIX DESIGNS

.1 Furnish test results and mix designs as requested.

.2 Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Departmental Representative and may be authorized as recoverable.

1.6 MOCK-UPS

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

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

.3 Prepare mock-ups for Departmental Representative review with reasonable promptness and in orderly sequence, to not cause delays in Work.

.4 Failure to prepare mock-ups 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.

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

.6 Remove mock-up at conclusion of Work or when acceptable to Departmental Representative.

.7 Mock-ups may remain as part of Work.

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

1.7 MILL TESTS

.1 Submit mill test certificates as required of specification Sections.

PART 2 – PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 – EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

1.2 INSTALLATION AND REMOVAL

.1 Provide temporary utilities controls in order to execute work expeditiously.

.2 Remove from site all such work after use.

1.3 WATER SUPPLY

.1 Departmental Representative will provide continuous supply of potable water for construction use.

1.4 TEMPORARY POWER

.1 Departmental Representative will pay for temporary power during construction for temporary heating, lighting and operating of power tools, to a maximum supply of 230 volts 30 amps.

.2 Temporary power for electric cranes and other equipment requiring in excess of above is responsibility of Contractor.

.3 Maximum power supply of 230 V, single phase, 60 Hz is available and will be provided for construction use at no cost. Connect to existing power supply in accordance with Canadian Electrical Code.

1.5 TEMPORARY COMMUNICATION FACILITIES

.1 Provide own cell phone during the course of the Work for communication with Departmental Representative

1.6 FIRE PROTECTION

.1 Provide and maintain temporary fire protection equipment during performance of Work required by governing codes, regulations and bylaws.

.2 Burning rubbish and construction waste materials is not permitted 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 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 INSTALLATION AND REMOVAL

.1 Provide construction facilities in order to execute work expeditiously.

.2 Remove from site all such work after use.

1.4 SCAFFOLDING

.1 Scaffolding in accordance with CAN/CSA-S269.2.

.2 Provide and maintain scaffolding, ramps, ladders, platforms, temporary stairs.

1.5 HOISTING

.1 Provide, operate and maintain hoists, cranes and lifts required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.

.2 Hoists, cranes and lifts to be operated by qualified operator.

1.6 SITE STORAGE/LOADING

.1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.

.2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

1.7 CONSTRUCTION PARKING

.1 Parking is as specified on Architectural Drawing A0.02. Do not occupy any other parking areas without the approval of the Departmental Representative.

1.8 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.

.2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

1.9 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

.2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.10 CONSTRUCTION SIGNAGE

.1 The use of construction signs is at the sole discretion of the Departmental Representative.

1.11 PROTECTION AND MAINTENANCE OF TRAFFIC

.1 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs

.2 Protect travelling public from damage to person and property.

.3 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

1.12 CLEAN-UP

.1 Remove construction debris, waste materials, packaging material from work site daily.

.2 Store materials resulting from demolition activities that are salvageable.

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 General Standards Board (CGSB)

.1 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.

.2 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.

.2 Canadian Standards Association (CSA International)

.1 CSA-O121-M1978(R2003), Douglas Fir Plywood.

1.2 INSTALLATION AND REMOVAL

.1 Provide temporary controls in order to execute Work expeditiously.

.2 Remove from site all such work after use.

1.3 SITE FENCING

.1 Where necessary for the protection of materials, Work and public, erect temporary site enclosures using purpose made, prefabricated interlocking metal fence panels 6'-0" high.

1.3 HOARDING

.1 Where necessary for the protection of materials, Work and occupants, erect temporary localized enclosures using plywood.

.2 Co-ordinate hoarding in conjunction with work phasing and to allow researcher access to required compartments during construction.

1.4 GUARD RAILS AND BARRICADES

.1 Provide secure, rigid guard rails and barricades around open edges of roofs.

.2 Provide as required by WorkSafeBC.

1.5 WEATHER ENCLOSURES

.1 Provide weather tight closures to unfinished openings, tops of shafts and other openings in floors and roofs.

.2 Design enclosures to withstand wind pressure.

1.6 PUBLIC TRAFFIC FLOW

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

1.7 FIRE ROUTES

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

1.8 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

.1 Protect surrounding private and public property from damage during performance of Work.

.2 Be responsible for damage incurred.

1.9 PROTECTION OF BUILDING FINISHES

.1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.

.2 Provide necessary screens, covers, and hoardings.

.3 Confirm with Departmental Representative locations and installation schedule 10 days prior to installation.

.4 Be responsible for damage incurred due to lack of or improper protection.

1.10 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for 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 REFERENCES

.1 Within text of each specifications section, reference may be made to reference standards.

.2 Conform to these reference standards, in whole or in part as specifically requested in specifications.

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

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

1.2 QUALITY

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

.2 Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.

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

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

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

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

1.3 AVAILABILITY

.1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

.2 In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.4 STORAGE, HANDLING AND PROTECTION

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

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

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

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

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

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

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

1.5 TRANSPORTATION

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

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

1.6 MANUFACTURER'S INSTRUCTIONS

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

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

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

1.7 QUALITY OF WORK

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

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

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

1.8 CO-ORDINATION

.1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.

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

1.9 CONCEALMENT

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

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

1.10 REMEDIAL WORK

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

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

1.11 FASTENINGS

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

.2 Prevent electrolytic action between dissimilar metals and materials.

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

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

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

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

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

1.12 PROTECTION OF WORK IN PROGRESS

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

PART 2 – PRODUCTS

2.1 Not Used

.1 Not Used.

PART 3 – EXECUTION

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit written request in advance of cutting or alteration which affects:

- .1 Structural integrity of elements of project.
- .2 Integrity of weather-exposed or moisture-resistant elements.
- .3 Efficiency, maintenance, or safety of operational elements.
- .4 Visual qualities of sight-exposed elements.
- .5 Work of Owner or separate contractor.

.3 Include in request:

- .1 Identification of project.
- .2 Location and description of affected Work.
- .3 Statement on necessity for cutting or alteration.
- .4 Description of proposed Work, and products to be used.
- .5 Alternatives to cutting and patching.
- .6 Effect on Work of Owner or separate contractor.
- .7 Written permission of affected separate contractor.
- .8 Date and time work will be executed.

1.2 MATERIALS

.1 Required for original installation.

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

1.3 PREPARATION

.1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

.2 After uncovering, inspect conditions affecting performance of Work.

.3 Beginning of cutting or patching means acceptance of existing conditions.

.4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.

.5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

1.4 EXECUTION

.1 Execute cutting, fitting, and patching to complete Work.

.2 Fit several parts together, to integrate with other Work.

.3 Uncover Work to install ill-timed Work.

.4 Remove and replace defective and non-conforming Work.

.5 Remove samples of installed Work for testing.

.6 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.

.7 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.

.8 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

.9 Restore work with new products in accordance with requirements of Contract Documents.

.10 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

.11 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for 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 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.

.2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative.

.3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

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

.5 Provide and use marked separate bins for recycling. Refer to Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.6 Dispose of waste materials and debris at licensed facilities.

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

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

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

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

1.2 FINAL CLEANING

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

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

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

.4 Clean and remove any debris, oil, or grime on glass resultant of work.

.5 Remove waste products and debris other than that caused by Owner or other Contractors.

.6 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.

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

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

.9 Remove dirt and other disfiguration from exterior surfaces.

.10 Clean and sweep roofs.

.11 Sweep and wash clean paved areas.

.12 Clean roofs, downspouts, and drainage systems.

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

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 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 WASTE MANAGEMENT GOALS

.1 Prior to start of Work conduct meeting with Departmental Representative to review and discuss PWGSC's waste management goal and Contractor's proposed Waste Reduction Workplan for Construction, Renovation and /or Demolition (CRD) waste to be project generated.

.2 PWGSC's waste management goal: to divert a minimum 75 percent of total Project Waste from landfill sites. Prior to project completion provide Departmental Representative documentation certifying that waste management, recycling, reuse of recyclable and reusable materials have been extensively practiced.

.3 Specific material target percentages for reuse and/or recycling:

.1 Metals: 100%

.2 Packaging: 80%.

.4 Target percentage goals are achievable for waste diversion. Contractor to review and confirm Departmental Representative's Waste Audit acceptable values.

.5 Minimize amount of non-hazardous solid waste generated by project and accomplish maximum source reduction, reuse and recycling of solid waste produced by construction activities.

.6 Protect environment and prevent environmental pollution damage.

1.2 REFERENCES

.1 Definitions:

.1 Approved/Authorized recycling facility: waste recycler approved by applicable provincial authority or other users of material for recycling approved by the Departmental Representative.

.2 Class III: non-hazardous waste - construction renovation and demolition waste.

.3 Construction, Renovation and/or Demolition (CRD) Waste: Class III solid, non- hazardous waste materials generated during construction, demolition, and/or renovation activities

.4 Inert Fill: inert waste - exclusively asphalt and concrete.

.5 Waste Source Separation Program (WSSP): implementation and co-ordination of ongoing activities to ensure designated waste materials will be sorted into pre- defined categories and sent for recycling and reuse, maximizing diversion and potential to reduce disposal costs.

.6 Recyclable: ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse.

.7 Recycle: process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.

.8 Recycling: process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

.9 Reuse: repeated use of product in same form but not necessarily for same purpose. Reuse includes:

.1 Salvaging reusable materials from re-modelling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.

.2 Returning reusable items including pallets or unused products to vendors.

.10 Salvage: removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.

.11 Separate Condition: refers to waste sorted into individual types.

.12 Source Separation: act of keeping different types of waste materials separate beginning from the point they became waste.

.13 Waste Diversion Report: detailed report of final results, quantifying cumulative weights and percentages of waste materials reused, recycled and landfilled over course of project. Measures success against Waste Reduction Workplan (WRW) goals and identifies lessons learned.

.14 Waste Management Co-ordinator (WMC): contractor representative responsible for supervising waste management activities as well as co-ordinating required submittal and reporting requirements.

.15 Waste Reduction Workplan (WRW): written report which addresses opportunities for reduction, reuse, or recycling of materials generated by project. Specifies diversion goals, implementation and reporting procedures, anticipated results and responsibilities.

.2 Reference Standards:

.1 Public Works and Government Services Canada (PWGSC)

.1 2002 National Construction, Renovation and Demolition Non-Hazardous Solid Waste Management Protocol.

.2 CRD Waste Management Market Research Report (available from PWGSC's Environmental Services).

.3 Sustainable Development Strategy 2007-2009: Target 2.1 Environmentally Sustainable Use of Natural Resources.

1.3 DOCUMENTS

.1 Post and maintain in visible and accessible area at job site, one copy of following documents:

.1 Waste Reduction Workplan (Schedule B).

.2 Waste Source Separation Program.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Prepare and submit following prior to project start-up:

.1 1 copy and 1 electronic copy of completed Waste Reduction Workplan (WRW): Schedule B.

.2 1 copy and 1 electronic copy of Waste Source Separation Program (WSSP).

.3 Prepare and submit on weekly basis, throughout project or at intervals agreed to by Departmental Representative the following:

.1 Receipts, scale tickets, waybills, and/or waste disposal receipts that show quantities and types of materials reused, recycled, or disposed of.

.2 Written once every two weeks summary report detailing cumulative amounts of waste materials reused, recycled and landfilled, and brief status of ongoing waste management activities.

.4 Submit prior to final payment the following:

.1 Waste Diversion Report, indicating final quantities in tones by material types salvaged for reuse, recycling or disposal in landfill and recycling centres, re-use depots, landfills and other waste processors that received waste materials.

.2 Provide receipts, scale tickets, waybills, waste disposal receipts that confirm quantities and types of materials reused, recycled or disposed of and destination.

1.5 WASTE REDUCTION WORKPLAN (WRW)

.1 Prepare and submit WRW (Schedule B) at least 10 days prior to project start-up.

.2 WRW identifies strategies to optimize diversion through reduction, reuse, and recycling of materials and comply with applicable regulations.

.3 WRW should include but not limited to:

.1 Applicable regulations.

.2 Specific goals for waste reduction, identify existing barriers and develop strategies to overcome them.

.3 Destination of materials identified.

.4 Deconstruction/disassembly techniques and schedules.

.5 Methods to collect, separate, and reduce generated wastes.

.6 Location of waste bins on-site.

.7 Security of on-site stock piles and waste bins.

.8 Protection of personnel, sub-contractors.

.9 Clear labelling of storage areas.

.10 Training plan for contractor and sub-contractors.

.11 Details on materials handling and removal procedures.

.12 Recycler and reclaimer requirements.

.13 Quantities of materials to be salvaged for reuse or recycled and materials sent to landfill.

.14 Requirements for monitoring on-site wastes management activities.

.4 Structure WRW to prioritize actions and follow 3R's hierarchy, with Reduction as first priority, followed by Reuse, then Recycle.

.5 Post WRW or summary where workers at site are able to review content.

.6 Monitor and report on waste reduction by documenting total volume (in tonnes) and cost of actual waste removed from project.

1.6 WASTE SOURCE SEPARATION PROGRAM (WSSP)

.1 As part of Waste Reduction Workplan, prepare WSSP prior to project start-up.

.2 WSSP will detail methodology and planned on-site activities for separation of reusable and recyclable materials from waste intended for landfill.

.3 Provide list and drawings of locations that will be made available for sorting, collection, handling and storage of anticipated quantities of reusable and recyclable materials.

.4 Provide sufficient on-site facilities and containers for collection, handling, and storage of anticipated quantities of reusable and recyclable materials.

.5 Locate containers to facilitate deposit of materials without hindering daily operations.

.6 Provide training for sub-contractors and workers in handling and separation of materials for reuse and/or recycling.

.7 Locate separated materials in areas which minimizes material damage.

.8 Clearly and securely label containers to identify types/conditions of materials accepted and assist sub-contractors and workers in separating materials accordingly.

.9 Monitor on-site waste management activities by conducting periodic site inspections to verify: state of signage, contamination levels, bin locations and condition, personnel participation, use of waste tracking forms and collection of waybills, receipts and invoices.

.10 On-site sale of salvaged materials is not permitted unless authorized in writing by Departmental Representative and provided that site safety regulations and security requirements are adhered to.

1.7 USE OF SITE AND FACILITIES

.1 Execute Work with minimal interference and disturbance to normal use of premises.

.2 Maintain security measures established by facility provide temporary security measures approved by Departmental Representative.

1.8 WASTE PROCESSING SITES

.1 Contractor is responsible to research and locate waste diversion resources and service providers. Salvaged materials are to be transported off site to approved and/or authorized recycling facilities or to users of material for recycling.

1.9 QUALITY ASSURANCE

.1 After award of Contract, a mandatory site examination will be held for this Project for Contractor and/or sub-contractors responsible for construction, renovation demolition/deconstruction waste management.

.1 Date, time and location will be arranged by Departmental Representative.

.2 Waste Management Meeting: Waste Management Co-ordinator is to provide an on status of waste diversion and management activities at each meeting. Written once every two weeks Waste Diversion Report summary to be provided by Waste Management Coordinator.

1.10 STORAGE, HANDLING AND PROTECTION

.1 Store, materials to be reused, recycled and salvaged in locations as directed by Departmental Representative.

.2 Unless specified otherwise, materials for removal become Contractor's property.

.3 Protect, stockpile, store and catalogue salvaged items.

.4 Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to licensed disposal facility.

.5 Protect structural components not removed and salvaged materials from movement damage.

.6 Support affected structures. If safety of building is endangered, cease operations and immediately notify Departmental Representative.

.7 Protect surface drainage, mechanical and electrical from damage and blockage.

.8 Provide on-site facilities and containers for collection and storage of reusable and recyclable materials.

.9 Separate and store materials produced during project in designated areas.

.10 Prevent contamination of materials to be salvaged and recycled and handle materials accordance with requirements for acceptance by designated processing facilities.

.1 On-site source separation is recommended.

.2 Remove co-mingled materials to off site processing facility for separation.

.3 Obtain waybills, receipts and/or scale tickets for separated materials removed from site.

.4 Materials reused on-site are considered to be diverted from landfill and as such are to be included in all reporting.

1.11 DISPOSAL OF WASTES

.1 Do not bury rubbish or waste materials.

.2 Do not dispose of waste, volatile materials, mineral spirits, oil, paint thinner, into waterways, storm, or sanitary sewers.

.3 Keep records of construction waste including:

.1 Number and size of bins.

.2 Waste type of each bin.

.3 Total tonnage generated.

.4 Tonnage reused or recycled.

.5 Reused or recycled waste destination.

.4 Remove materials on-site as Work progresses.

.5 Prepare project summary to verify destination and quantities on a material-by-material basis as identified in the waste audit.

1.12 SCHEDULING

.1 Co-ordinate 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 WRW and WSSP.

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

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

.2 Source separate materials to be reused/recycled into specified sort areas.

3.3 DIVERSION OF MATERIALS

.1 From following list, separate materials from general waste stream and stockpile in separate piles or containers, as reviewed by Departmental Representative, and consistent with applicable fire regulations.

.1 Mark containers or stockpile areas.

.2 Provide instruction on disposal practices.

.2 On-site sale of materials is not permitted.

3.4 WASTE DIVERSION REPORT

.1 At completion of Project, prepare written Waste Diversion Report indicating quantities of materials reused, recycled or disposed of as well as the following:

.1 Identify final diversion results and measure success against goals from Waste Reduction Workplan.

.2 Compare final quantities/percentages diverted with initial projections in Waste Audit and Waste Reduction Workplan and explain variances.

.1 Supporting documentation.

.2 Waybills and tracking forms.

.3 Description of issues, resolutions and lessons learned.

3.5 WASTE REDUCTION WORKPLAN (WRW)

.1 Schedule B

(1) Material Category	(2) Person(s) Respon-sible	(3) Total Quantity of Waste (unit)	(4) Reused Amount (units) Projected	Actual	(5) Recycled Amount (unit) Projected	Actual	(6) Material(s) Destina-tion
Warped Pallet							
Plastic Packaging							
Card- board Packaging							
Other							
Metal							
Other							

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Inspections and declarations.
.2 Closeout submittals.
.3 Operation and Maintenance Manual: Format and contents of each volume.
.4 Recording actual site conditions.
.5 Record (as-built) documents and samples.
.6 Warranties and bonds.

1.2 RELATED SECTIONS

.1 Section 01 33 00 – Submittal Procedures.
.2 Section 01 45 00 – Quality Control.
.3 Section 01 78 00 – Closeout Submittals.
.4 This Section describes requirements applicable to all Sections within Divisions 02 to 49.

1.3 INSPECTIONS AND DECLARATIONS

.1 Contractor's Inspection: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.1 Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.

.2 Request Departmental Representative inspection.

.2 Departmental Representative Inspection:

.1 Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.

.2 Contractor to correct Work as directed.

.3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:

.1 Work: completed and inspected for compliance with Contract Documents.

.2 Defects: corrected and deficiencies completed.

.3 Equipment and systems have been, per the Cx plan, tested, adjusted, and balanced and are operational.

.4 Certificates required by authorities having jurisdiction have been submitted.

.5 Operation of systems have been demonstrated to Owner’s personnel.

.6 Work is complete and ready for Final Inspection.

.4 Final Inspection:

.1 When completion tasks are done, request final inspection of Work by Departmental Representative, and Contractor.

.2 When Work is incomplete according to Departmental Representative, complete outstanding items and request re-inspection.

.5 Declaration of Substantial Performance: when Departmental Representative

considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

.6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.

.7 Final Payment:

.1 When Departmental Representative considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

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

1.4 OPERATION AND MAINTENANCE MANUALS

.1 Submit to the Departmental Representative two (2) copies of maintenance, operating and instruction manuals.

.2 Separately bound manuals are to be prepared for the following trade work:

.1 Building: Architectural elements - hardware

.2 Mechanical: Heating

.3 Electrical: Power, fire alarm system, etc.

.4 Greenhouse: Controls, sensors, shades and blackout, motors, etc.

.3 Provide maintenance manuals in hard and electronic format as specified hereafter, giving full operating and maintenance instructions for each system and major piece of equipment, as well as, maintenance instructions for building elements, fixtures and finishes.

.4 Manuals are to contain pertinent maintenance, operational and installation instruction information on equipment, materials cleaning and lubrication schedules, overhaul, replacement, adjustment schedules, and emergency procedures as applicable. Instruction in manuals shall be in simple language so as to guide the Owner in the proper operation and maintenance of building material, components, equipment and systems.

.5 Include all items covered by Change Orders.

.6 Update manuals during the installation and commissioning phase of the Work so that manuals are final by the scheduled turnover date.

.7 Include any equipment supplied by the Owner and pre-tendered equipment.

.8 Binders:

.1 Binders shall be ACCO Canadian Co. Ltd. or approved substitution as follows:

.1 ACCO Inview D-Ring Binders - color Black

a. 1 inch - 41805-0

b. 2 inch – 41807

.2 ACCO expanding bar-lock catalogue binder - color Black

3 to 5.5 inches - 05436-0

.9 Pages:

.1 Descriptions and lists are to be neatly typed or printed on 216mm x 280mm heavy bond paper. Duplicate pages shall be made by electrostatic dry copier.

.2 The maximum paper size for schedules and diagrams is 280mm x 432mm. Larger paper sizes will be accepted for diagrams only if mylar sepia is provided for each sheet.

.3 Alphabetical index tab separators are to be used in each manual to identify each information "Section."

.10 Manual contents shall be organized into applicable categories of Work, parallel to specifications divisions and sections.

.11 Architectural/Greenhouse manuals shall include in general, but not be limited to, the following:

.1 List of Subcontractors, manufacturers, suppliers, complete with addresses and telephone and facsimile numbers.

.2 Hardware with the actual manufacturer, supplier and identification names and numbers.

.3 All manufacturer's equipment, materials, products, data, details, identification, list, schedules of maintenance, operational and installation instruction information as required in accordance with the various sections of the specification.

.4 All extended guarantees, warranties, maintenance bonds, certificates, letters of guarantees, registration cards, as called for in the various sections of the specification, with the following information:

.1 Name and address of subject.

.2 Commencement date (Substantial Performance of the Work) of guarantees and warranties.

.3 Duration and expiry date of guarantees and warranties.

.4 Signature and seal of the Contractor, installer, manufacturer and/or supplier as applicable.

.5 Complete set of all final reviewed shop drawings.

.6 Certificates of Inspection.

.7 Test reports and certificates as applicable.

.8 Confirmation letters of all extra, reserve, replacement materials as required in accordance with various sections of the specification has been properly handed over and received by the Owner in good order.

.9 Confirmation letters of all special tools and keys as applicable, has been properly handed over and received by the Owner in good order.

.10 Submit to the Departmental Representative two (2) copies of the Mechanical and Electrical manuals in accordance with this section and to detailed requirements

specifically set out in the various sections of the specification as applicable.

1.5 ELECTRONIC COPIES OF MANUALS

.1 In addition to the printed copies, submit electronic copies of all operating and maintenance data as specified under Section 1.2.

.2 Submit data on "read-only" CDs. Provide one (1) copy of each CD for the Departmental Representative and one (1) copy to the Consultant.

.3 Do not provide separate CD's for each major section. Use more than one CD only if the volume of data exceeds the capacity of a single CD. Professionally label each CD and CD jewel case, including the name of the Owner, project and CD title.

.4 Organize electronic data using directories and sub-directories as generally described in Section 1.2. Prior to assembling the electronic data, submit to the Consultant a detailed list of the proposed directory/sub-directory structure including proposed file names. File names are to be concise and descriptive so as to be easily recognizable without the need to open the document to know what information the file contains. Directory structure and file naming is subject to the approval of the Consultant.

.5 Provide information in Portable Document Format (PDF). Break down large files into sections and use bookmark structure for easy navigation.

1.6 RECORDING ACTUAL SITE CONDITIONS

.1 Record information on set of black line opaque drawings, and within the Project Manual, provided by Consultant.

.2 Annotate with coloured felt tip marking pens, maintaining separate colours for each major system, for recording changed information.

.3 Record information concurrently with construction progress. Do not conceal Work of the Project until required information is accurately recorded.

.4 Contract drawings and shop drawings: Legibly mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes made by Change Orders.

.6 Details not on original Contract Drawings.

.7 References to related shop drawings and modifications.

.5 Specifications: Legibly mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and Change Orders.

.6 Other Documents: Maintain manufacturer's certifications, inspection certifications and field test records required by individual specifications sections.

1.7 RECORD (AS-BUILT) DOCUMENTS AND SAMPLES

.1 In addition to requirements in General Conditions, maintain at the site for Consultant, one (1) record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Site Instructions, Change Directives, Change Orders and other modifications to the Contract.

.5 Reviewed Shop Drawings, Product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store as-built documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.

.3 Label as-built documents and file in accordance with section number listings in List of Contents of the Project Manual. Label each document "AS-BUILT DOCUMENTS" in large, printed letters.

.4 Maintain as-built documents in clean, dry and legible condition. Do not use as-built documents for construction purposes.

.5 Keep as-built documents and samples available for inspection by Consultant.

1.8 RECORD DOCUMENTS

.1 Prior to Substantial Performance of the Work, transfer the marked up information from the as-built documents to a master set of drawing files provided by the Consultant, as follows:

.1 Drawings: AutoCAD Release 2010.

.2 Mark revised documents as "RECORD DOCUMENTS". Include all revisions, with special emphasis on Greenhouse controls, systems, mechanical, and electrical.

.3 Employ a competent computer draftsperson to indicate changes on the electronic set of record drawings. Provide updated record drawings in AutoCAD Release 2010.

.4 Submit three (3) completed record documents to Departmental Representative on a CD, accompanied by three (3) hard copy sets.

1.9 WARRANTIES AND BONDS

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

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten (10) days after completion of the applicable item of work.

.4 Except for items put into use with Contractor's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.

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

.6 Co-execute submittals when required.

.7 Retain warranties and bonds until time specified for submittals.

1.10 FINAL CLEANING

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

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

.2 Waste Management: separate waste materials for 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 Pre-warranty Meeting:

.1 Convene meeting one week prior to contract completion with Departmental Representative, in accordance with Section 01 31 19 - Project Meetings to:

.1 Verify Project requirements.

.2 Review warranty requirements, manufacturer's installation instructions.

.2 Departmental Representative to establish communication procedures for:

.1 Notifying construction warranty defects.

.2 Determine priorities for type of defects.

.3 Determine reasonable response time.

.3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.

.4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of operating and maintenance manuals in English .

.3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.

.4 Provide evidence, if requested, for type, source and quality of products supplied.

1.3 FORMAT

.1 Organize data as instructional manual.

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used correlate data into related consistent groupings.

.1 Identify contents of each binder on spine.

.4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, under Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab.

.1 Bind in with text; fold larger drawings to size of text pages.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

.1 Table of Contents for Each Volume: provide title of project;

.1 Date of submission; names.

.2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.

.3 Schedule of products and systems, indexed to content of volume.

.2 For each product or system:

.1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: as required to supplement product data.

.1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

1.5 AS -BUILT DOCUMENTS AND SAMPLES

.1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Change Orders and other modifications to Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in field office apart from documents used for construction.

.1 Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.

.1 Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition.

.1 Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by Departmental Representative.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Departmental Representative.

.2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress.

.1 Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 References to related shop drawings and modifications.

.5 Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

.6 Other Documents: maintain inspection certifications, field test records, required by individual specifications sections.

.7 Provide digital photos, if requested, for site records.

1.7 EQUIPMENT AND SYSTEMS

.1 For each item of equipment and each system include description of unit or system, and component parts.

.1 Give function, normal operation characteristics and limiting conditions.

.2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.

.1 Include regulation, control, stopping, shut-down, and emergency instructions.

.2 Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Additional requirements: as specified in individual specification sections.

1.8 MATERIALS AND FINISHES

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

Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.2 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Additional requirements: as specified in individual specifications sections.

1.9 MAINTENANCE MATERIALS

.1 Spare Parts:

.1 Provide spare parts, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Departmental Representative.

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

.2 Extra Stock Materials:

.1 Provide maintenance and extra materials, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Departmental Representative.

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

.3 Special Tools:

.1 Provide special tools, in quantities specified in individual specification section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to Departmental Representative.

.2 Include approved listings in Maintenance Manual.

1.10 DELIVERY, STORAGE AND HANDLING

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

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

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and for review by Departmental Representative.

1.11 WARRANTIES AND BONDS

.1 Develop warranty management plan to contain information relevant to Warranties.

.2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Departmental Representative approval.

.3 Warranty management plan to include required actions and documents to assure that Departmental Representative receives warranties to which it is entitled.

.4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.

.5 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.

.6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

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

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

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

.5 Co-execute submittals when required.

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

.7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.8 Conduct joint 4 month and 9 month warranty inspection, measured from time of acceptance, by Departmental Representative.

.9 Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include roofs, windows and glazing.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.10 Respond in timely manner to oral or written notification of required construction warranty repair work.

.11 Written verification to follow oral instructions.

.1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

1.12 WARRANTY TAGS

.1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Departmental Representative.

.2 Attach tags with copper wire and spray with waterproof silicone coating.

.3 Leave date of acceptance until project is accepted for occupancy.

.4 Indicate following information on tag:

.1 Type of product/material.

.2 Model number.

.3 Serial number.

.4 Contract number.

.5 Warranty period.

.6 Inspector's signature.

.7 Construction Contractor.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements relating to commissioning of project's components and systems, specifying general requirements to Performance Verification of components, equipment, sub-systems, systems, and integrated systems.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures
.2 Section 01 45 00 - Quality Control.
.3 Section 01 91 13 - General Commissioning Cx Requirements
.4 Section 01 91 31- Commissioning (Cx) Plan
.5 Section 01 91 33 - Cx Forms.
.6 Section 23 05 00 - Common Work Results - Mechanical
.7 Section 23 05 93 - Testing, Adjusting And Balancing for HVAC.
.8 Section 23 08 00 - Commissioning of Mechanical Systems
.9 Section 25 05 01 – EMCS General Requirements
.10 Section 25 90 11 – EMCS: Sequence of Operations
.11 Section 26 05 00 - Common Work Results - Electrical.
.12 Section 26 29 10 - Motor Starters to 600V.
.13 Section 28 31 01- Fire Detection and Alarm.

.3 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 PV - Performance Verification.
.7 TAB - Testing, Adjusting and Balancing.
.8 CxA – Commissioning Authority.
.9 DC – Design Consultant.
.10 PWGSC – Public Works and Government Services Canada.
.11 ECxC – Electrical Commissioning Coordinator.
.12 MCxC – Mechanical Commissioning Coordinator.
.13 QCM - .Quality control Manger.
.14 ECA – Electrical Commissioning Agent.
.15 MCA – Mechanical Commissioning Agent.
.16 O&M – Operations and Maintenance.

1.2 REFERENCE

.1 CSA Z320-11 Standard

1.3 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 Cx is to be performed by an independent third party professional Cx Agent(s) after work is completed and prior to energizing any equipment. The independent third party must have performed similar HV work for a minimum of 5 years. Qualifications of Cx Agent submitted by General Contractor shall be reviewed by Commissioning Authority and can only be hired after acceptance by Departmental Representative.

.3 General Contractor to retain the services of an independent third party professional Cx Agent to carry out the tests and calibration as required herein. Testing Agency shall be familiar with NETA Standards as specified herein and shall have accreditation equivalent to a full NETA member company:

.1 This project shall only be undertaken by firms familiar with and having a long and demonstrable successful track record in the field of switchgear and transformer modification and installation, protection and control, and arc flash mitigation. The proponent shall be experienced in working with an industrial type primary voltage distribution system using parallel feeders. Provide documented experience on projects of this type.

.2 All protection settings must be reviewed by a Professional Engineer registered in British Columbia who is an employee of Cx Agency. Provide documentation naming this individual along with their credentials.

.3 All work must be performed by qualified technicians/electricians with applicable accreditation for the appropriate permitting required. Provide a list of all personnel and their qualifications.

.4 Provide three references, including contact information for completed projects similar to this in scope and technical content.

.5 Qualifications of the Cx Agency must be submitted and reviewed by Departmental Representative and only after acceptance will the Testing Agency be allowed to perform the work.

.4 Furnish Independent Cx agency professional engineer’s letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions. The letter is to be submitted stamped by a Professional Engineer, registered in BC, and provided to the Commissioning Authority.

.5 Employ only personnel who are qualified and experienced in high voltage work. Personnel must be familiar with the equipment and procedures necessary to complete the work as specified herein.

.6 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 must interact with each other as intended in accordance with Contract Documents and design criteria.

.2 During these checks, adjustments will be made to enhance performance to meet environmental or user requirements.

.7 Design Criteria: as per client's requirements or determined by designer to meet Project functional and operational requirements.

1.4 COMMISSIONING OVERVIEW

.1 Cx to be a line item of General Contractor's cost breakdown.

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

.3 Cx is to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities include the transfer of critical knowledge to facility operational personnel.

.4 Complete all start-up and verification of systems prior to review by Commissioning Agent.

.1 To bring mechanical, electrical and building architectural systems and components from a state of static completion to a state of dynamic operation.

.2 To verify conformance to contract requirements.

.3 To confirm installations meet requirements of Contract Documents.

.4 To provide all testing documents and records.

.5 To ensure completed facility meets contract requirements.

.6 To provide a documented operator training program.

.7 To verify accuracy of project record drawings and operating and maintenance manuals.

.5 Departmental Representative will issue Certificate of Substantial Completion when:

.1 Completed Cx documentation has been received, reviewed for suitability and approved by Commissioning Authority.

.2 Equipment, components and systems have been commissioned.

.3 O&M staff training has been completed.

1.5 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 un-functional system, including related systems as deemed required by the Commissioning Authority, Commissioning Authority 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 General Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.6 PRE-CX REVIEW

.1 Before Construction:

.1 Review contract documents, confirm by writing to Commissioning Authority.

.1 Adequacy of provisions for Cx.

.2 Aspects of design and installation pertinent to success of Cx.

.2 During Construction:

.1 Co-ordinate provision, location and installation of provisions for Cx.

.3 Before start of Cx:

.1 Have completed Cx Plan up-to-date.

.2 Ensure installation of related components, equipment, sub-systems, systems is complete.

.3 Fully understand Cx requirements and procedures.

.4 Have Cx documentation shelf-ready.

.5 Understand completely design criteria and intent and special features.

.6 Submit complete start-up documentation to Departmental Representative.

.7 Have Cx schedules up-to-date.

.8 Ensure systems have been cleaned thoroughly.

.9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.

.10 Submit factory testing report of Electrical Equipment to Departmental Representative for review and approval.

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

.12 Conduct coordination and protection study of upstream breakers, as indicated in drawings, to determine if trip settings are adequate for additional demand. Determine trip setting adjustments and where required, re-set breaker parameters accordingly. The study shall be performed at both 12.5 kV and 25 kV distribution voltages.

.13 Factory test each transformers, regulator and switchgear assemblies and all accessories. Notify Commissioning Authority 7 days in advance of tests and confirm 2 days in advance. Commissioning Authority and Engineer will attend/witness tests. Tests must be conducted in the Lower Mainland area of British Columbia. Alternatively, if tests are conducted elsewhere, pay the costs of travel time (at $130/hour) and all travel/living expenses for two attendees (at actual cost) associated with Commissioning Authority and engineer’s attendance at factory tests and at repeat tests if necessary.

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

1.7 CONFLICTS

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

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

1.8 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit no later than 4 weeks after award of Contract:

.1 Name of Contractor's Cx agent.

.2 Draft Cx documentation.

.3 Preliminary Cx schedule.

.2 Request in writing to Commissioning Authority for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.

.3 Submit proposed Cx procedures to Commissioning Authority where not specified and obtain written approval at least 8 weeks prior to start of Cx.

.4 Provide additional documentation relating to Cx process required by Departmental Representative, specifically;

.1 Cx Plan and Schedule

.2 Accepted Shop drawings

.3 Completed PI forms

.4 Approved TAB report

.5 Approved PV forms

.6 Approved O&M manuals

.7 Approved System and Integrated System Test Report

.8 Approved Factory testing reports

.9 Approved Training and Attendance forms

.10 Accepted “As-built” Plans and Specifications

.11 Final Cx Report

1.9 COMMISSIONING DOCUMENTATION

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Static Verification Forms, Startup and Functional Performance Testing Forms for requirements and instructions for use.

.2 General Contractor to review and approve Cx documentation submitted by Cx Agent prior to submission to Departmental Representative for review.

.3 Provide completed and approved Cx documentation to Commissioning Authority.

1.10 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 57 Construction Progress Schedule Bar (GANTT Chart).

.2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:

.1 Approval of Cx reports.

.2 Verification of reported results.

.3 Repairs, retesting, re-commissioning, re-verification.

.4 Training.

1.11 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings: Section 01 32 16.07 Construction Progress Schedule Bar (GANTT Chart) and as specified herein.

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

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

.4 At 60% construction completion stage. Section 01 32 16.07 Construction Progress Schedule Bar (GANTT Chart). General Contractor 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 General 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 General Contractor with their Commissioning Agent, who will record and distribute minutes.

.7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.12 STARTING AND TESTING

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

1.13 WITNESSING OF STARTING AND TESTING

.1 Provide 14 days’ notice prior to commencement.

.2 Commissioning Authority to witness of start-up and testing.

.3 General Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

.1 Minimum of 5 years experience 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 general 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 Prior to start-up:

.1 Insulation resistance test and continuity test of all new cables and all cables with connections changed during construction

.2 All high voltage terminations tested with infrared imaging. Spot temperature readings are not acceptable

.3 Refer to the NETA Acceptance Testing specifications for detailed commissioning requirements for the following equipment:

.1 Cables, Low Voltage, 600 volt maximum.

.2 Switches, Air, Low Voltage

.3 Circuit Breakers, Air, Insulated/Molded Case

.4 Circuit Breakers, Air, Low-Voltage Power

.5 Instrument Transformers

.6 Metering Devices, Microprocessor-Based

.7 Motor Control, Motor Starters, Low-Voltage

.8 Emergency Systems, Uninterruptable Power Systems

.9 Emergency Systems, Automatic Transfer Switches

.10 Fiber-Optic Cables

.4 Start-up: follow accepted start-up procedures.

.5 Operational testing: document equipment performance.

.6 System PV: include repetition of tests after correcting deficiencies.

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

.3 Conduct following tests in accordance with Section 01 45 00 - Quality Control.

.1 Power distribution system including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its control.

.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.5 Systems: fire alarm system communications.

.6 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000V instrument.

.3 Check resistance to ground before energizing.

.4 Correct deficiencies and obtain approval from Commissioning Authority after distinct phases have been completed and before commencing next phase.

.5 Document required tests on approved PV forms.

.6 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Commissioning Authority. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

.1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.

.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Commissioning Authority.

.3 If evaluation report concludes that major damage has occurred, Departmental Representative 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 Commissioning Authority for approval before commencement of commissioning.

.1 Start-up documentation to include:

.1 Factory and on-site test certificates for specified equipment.

.2 Pre-start-up inspection reports.

.3 Signed installation/start-up check lists.

.4 Start-up reports,

.5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

.1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

.2 With assistance of manufacturer develop written maintenance program and submit to Departmental Representative for approval before implementation.

.3 .Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate and maintain systems until issuance of Certificate of Substantial Performance.

1.17 TEST RESULTS

.1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.

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

1.18 START OF COMMISSIONING

.1 Notify Departmental Representative at least 4 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 Departmental Representative for review and approval:

.1 Complete list of instruments proposed to be used.

.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.

.2 Provide the following equipment as required:

.1 2-way radios.

.2 Ladders.

.3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:

.1 Under accepted simulated operating conditions, over entire operating range, in all modes.

.2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturer's operating instructions.

.4 EMCS trending to be available as supporting documentation for performance verification.

1.21 WITNESSING COMMISSIONING

.1 Cx Authority and Departmental Representative to witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

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

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

.3 Provide copies to Departmental Representative within 5 days of test and with Cx report.

.4 Authorities having jurisdiction in this project include Municipality of Port Hardy and BC Safety Authority.

1.23 EXTRAPOLATION OF RESULTS

.1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by Commissioning Authority in accordance with equipment

manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.

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 Commissioning Authority.

.2 Report problems, faults or defects affecting Cx to Commissioning Authority in writing. Stop Cx until problems are rectified. Proceed with written approval from Commissioning Authority.

1.26 COMPLETION OF COMMISSIONING

.1 Upon completion of Cx, leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities, complete Cx prior to issuance of Certificate of Substantial Performance.

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Commissioning Authority.

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 Departmental Representative 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 Commissioning Authority.

.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.

1.32 OWNER'S PERFORMANCE TESTING

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

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.

.2 Related Requirements

.1 Section 01 91 33 Cx Forms.

.2 Section 01 91 41 Cx Training.

1.2 REFERENCES

.1 CSA Z-320-11 Commissioning Standard.

1.3 GENERAL

.1 Provide fully functional facilities:

.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 Complete documentation relating to installed equipment and systems.

.2 Term "Cx" in this section means "Commissioning".

.3 Use this Cx Plan as master planning document for Cx:

.1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.

.2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.

.3 Sets out deliverables relating to O M, process and administration of Cx.

.4 Describes process of verification of how built works meet design requirements.

.5 Produces a complete functional system prior to issuance of Certificate of Substantial Performance.

.6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:

.1 Overview of Cx.

.2 General description of elements that make up Cx Plan.

.3 Process and methodology for successful Cx.

.4 Acronyms:

.1 Cx - Commissioning.

.2 BMM - Building Management Manual.

.3 EMCS - Energy Monitoring and Control Systems (aka DDC or BAS).

.4 MSDS - Material Safety Data Sheets.

.5 PI - Product Information.
.6 PV - Performance Verification.
.7 TAB - Testing, Adjusting and Balancing.
.8 WHMIS - Workplace Hazardous Materials Information System.
.9 CxA – Commissioning Authority.
.10 DC – Design Consultant.
.11 PWGSC – Public Works and Government Services Canada.
.12 ECxC – Electrical Commissioning Coordinator.
.13 MCxC – Mechanical Commissioning Coordinator.
.14 QCM - .Quality control Manger.
.15 ECA – Electrical Commissioning Agent.
.16 MCA – Mechanical Commissioning Agent.
.17 O&M – Operations and Maintenance.

1.4 Five Phases of Cx to be Used on This Project

.1 Each system is to be checked, verified and documented 4 times at the appropriate phase of installation, and to have the training & demonstration phase accepted and documented:

PHASE	DESCRIPTION	STATIC TEST	DYNAMIC TEST	FUNCTIONAL PERFORMANCE TEST
1	System readiness or Pre-functional Testing	✓		
2	System start-up, testing, balancing, and adjustment		✓	✓
3	Verification of integrated system performance		✓	✓
4	Demonstration and training	na	na	Na
5	Seasonal testing and verification	✓	✓	✓

1.5 DEVELOPMENT OF 100% CX PLAN

.1 Cx Plan to be 95% completed before added into Project Specifications.

.2 Cx Plan to be 100% completed by Contractor within 12 weeks of award of contract to take into account:

.1 Approved shop drawings and product data.
.2 Approved changes to contract.
.3 Contractor's project schedule.
.4 Cx schedule.
.5 Contractor's, sub-contractor's, suppliers' requirements.
.6 Project construction team's and Cx team's requirements.

.3 Submit completed Cx Plan to Commissioning Authority and obtain written approval.

1.6 REFINEMENT OF CX PLAN

.1 During construction phase, revise, refine and update Cx Plan to include:

.1 Changes resulting from Client program modifications.

.2 Approved design and construction changes.

.2 Submit each revised Cx Plan to Commissioning Authority for review every 3 months, and obtain written approval.

1.7 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

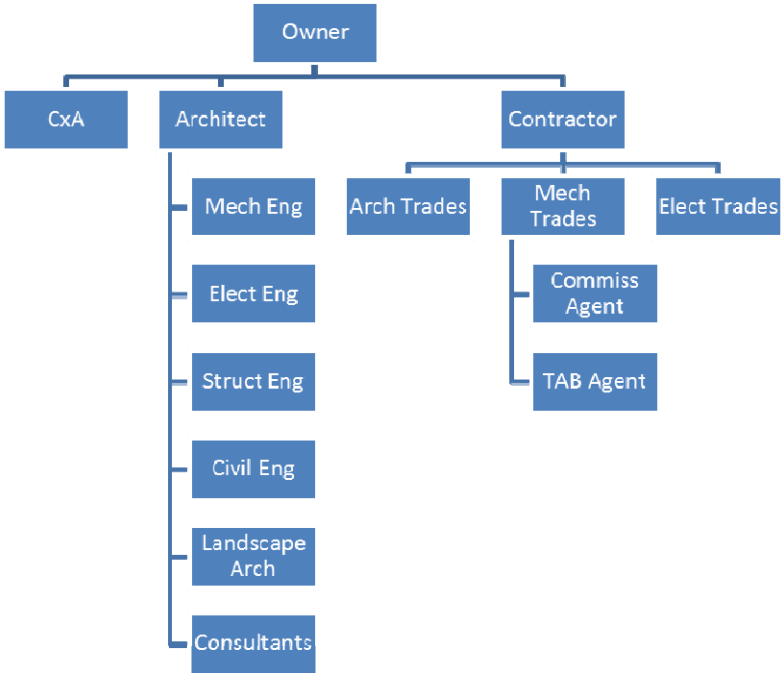
.1 General Contractor to maintain overall responsibility for project and is sole point of contact between members of commissioning team.

.2 The "Commissioning Team" consists of various participants involved in the Cx process. The table below lists team members, and shows some required tasks.

	Provide Design Intent	Review CxA's Design Review	Review Cx Plan	Respond to CxA Tender Review	Attend Cx Meetings	Other Duties Described Herein
Client: PWGSC		✓	✓	✓	✓	✓
Client: PWGSC Mechanical to Norman Paul PWGSC Commissioning Manager		✓	✓	✓	✓	✓
Architect (Consultant): IBI Group		✓	✓		✓	✓
General Contractor: To be determined			✓			✓
Owner's Commissioning Authority: Avalon			✓		✓	✓
Contractor's Mechanical Commissioning Agent: To be determined	✓	✓	✓	✓	✓	✓
Mechanical Engineer: MCW Engineering	✓	✓	✓	✓	✓	✓
Electrical Engineer: AES Engineering	✓	✓	✓	✓		✓
Envelope: IBI Group	✓	✓	✓	✓		✓
Civil Engineer: n/a						
Landscape Architect: n/a						
Testing and Balancing Agent: To be determined			✓		✓	✓
Controls Trade Contractor: To be determined			✓		✓	✓
Electrical Contractor: To be determined					✓	✓
Manufacturer's Representatives (as applicable): To be determined						✓
Inspectors and Testing Agencies: To be determined						✓

.3 This list is to be updated on an ongoing basis as tendering and hiring occurs.

.4 The project's preliminary Cx Organization Chart is as follows:



The team members' commissioning responsibilities are detailed in the specifications and this Commissioning Plan. The following is a summary table to assist team members in better understanding their roles:

LEGEND: "**A**" denotes ACCEPT; "**L**" denotes LEAD;
"**P**" denotes PARTICIPATE

TASK	Building owner or rep.	Building op's and maint. staff	Cx authority	Cx provider	Design consultants	Contractor& sub-contractors	Manuf' rep's	Independent testing specialists
Concept Phase								
Define owner's project req's	**L**				**P**			
Select a Cx authority	**L**							
Form a Cx team		**P**	**L**		**P**	**P**	**P**	
Review OPRs			**P**		**P**			
Include Cx responsibilities		**P**	**L**		**P**	**P**	**P**	
Determine scope and initial Cx budget	**A/L**		**P**		**P**			
Develop basis of design (BOD)			**P**		**L**	**P**	**P**	
Develop initial Cx plan outline			**L**		**P**	**P**	**P**	
Acceptance	**A**							
Design Phase								

Hold design phase Cx meetings		**P**	**L**		**P**	**P**	**P**	**P**
Identify project-specific Cx responsibilities		**P**	**L**		**P**	**P**	**P**	**P**
Verify OPR and BOD for completeness and clarity			**L**		**P**			
Perform Cx-focused design reviews of drawings and specs		**P**	**P**		**L**			
Plan/prepare verification checklists and test procedures			**L**		**P**	**P**	**P**	**P**
Define requirements for systems manuals		**P**	**P**		**L**	**P**		
Determine operational training requirements		**P**	**L/P**		**L/P**			
Develop Cx specifications	**A**		**P**		**L**			
Prepare Cx report			**L**					
Update Cx plan			**L**					
Acceptance	**A**							
Construction Phase								
Integrate Cx activities into project schedule			**P**			**L**		
Hold construction Cx phase kickoff and progress meetings		**P**	**L**	**P**	**P**	**P**	**P**	**P**
Review contractor submissions and shop drawings			**P**		**L**	**P**		
Construct mock-ups	**A**	**P**	**P**	**P**	**P**	**L**	**P**	**P**
Update OPR and BOD	**A**		**P**		**L**			
Perform and document static verification			**P**	**L/P**		**L/P**	**P**	**P**
Perform and document start-up			**P**	**P**		**L**	**P**	**P**
Perform and document functional performance testing		**P**	**P**	**L**		**P**	**P**	**P**
Prepare and update issues logs			**L**		**P**	**P**		
Resolve issues resulting from all tests			**P**	**P**	**L**	**P**		
Verify, review, and conduct training		**P**	**P**	**L**	**P**	**P**	**P**	
Review maintenance and data manuals		**P**	**P**		**L**	**P**		
Review operations manuals		**P**	**P**		**L**	**P**		
Prepare Cx report			**P**	**L**				

Update Cx plan			**L**					
Prepare Cx manual			**L**					
Acceptance	**A**							
Occupancy & operations phase								
Resolve outstanding Cx issues		**P**	**P**	**L**	**P**	**P**	**P**	**P**
Perform seasonal/deferred testing		**P**	**P**	**L**		**P**	**P**	**P**
Resolve issues resulting from seasonal/deferred tests		**P**	**P**	**L**	**P**	**P**	**P**	**P**
Update issues logs resulting from seasonal/deferred tests			**L**		**P**	**P**		
Complete final Cx report		**P**	**L**	**P**	**P**	**P**		
Acceptance	**A**							

1.8 DELIVERABLES RELATING TO O&M PERSPECTIVES

.1 General requirements:

.1 Compile English documentation.

.2 Documentation to be computer-compatible format ready for inputting for data management.

.2 Provide deliverables:

.1 Warranties.

.2 Project record documentation.

.3 Inventory of spare parts, special tools and maintenance materials.

.4 Maintenance Management System (MMS) identification system used.

.5 WHMIS information.

.6 MSDS data sheets.

.7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

.8 Other deliverables described later in this section.

1.9 DELIVERABLES RELATING TO THE CX PROCESS

.1 Consultants and CxA to witness and review sample tests and reports of results provided by Contractors.

1.10 CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Perform Cx by specified Cx agency using procedures reviewed by Commissioning Authority and Consultant.

.2 Commissioning Authority and Consultant to monitor Cx activities.

.3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

.4 Commissioning Authority reserves right to verify a percentage of reported results at no cost to contract.

1.11 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

.1 Cx to be performed by specified Cx specialist, using procedures developed by Contractor and approved by Commissioning Authority, and reviewed by Consultant.

.2 Sample of tests to be witnessed by Commissioning Authority and/or Consultant and documented on approved report forms.

.3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be reviewed by Commissioning Authority and Consultant.

.4 Commissioning Authority reserves right to verify percentage of reported results.

.5 Identification:

.1 In later stages of Cx, before hand-over and acceptance Consultant, Contractor, Project Manager, Property Manager and Cx Manager 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.

1.12 STATIC VERIFICATION FORMS

.1 Refer to Section 01 91 33 1.2 - Commissioning (Cx) Forms: Static Verification Forms.

1.13 START-UP FORMS

.1 Refer to Section 01 91 33 1.3 - Commissioning (Cx) Forms: Start-up Forms.

1.14 FUNCTIONAL PERFORMANCE TESTING

.1 Refer to Section 01 91 33 1.4 - Commissioning (Cx) Forms: Functional Performance Testing Forms.

1.15 DELIVERABLES RELATING TO ADMINISTRATION OF CX

.1 General:

.1 Complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.16 CX SCHEDULES

.1 Prepare detailed Cx Schedule and submit to Commissioning Authority and Consultant for review at the 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: 14 days after contract award, and before construction starts.

.3 Cx agents' credentials: 14 days after contract award and before start of Cx.

.4 Cx procedures: 14 days after contract award.

.5 Cx Report format: 14 days after contract award.

.6 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.

.7 Notification of intention to start TAB: 21 days 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 Identification of deferred Cx.

.12 Implementation of training plans.

.13 Cx reports: immediately upon successful completion of Cx.

.2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Departmental Representative.

.3 Allow for a day of work on site for MCxC, ECxC, MCA, ECA,TAB Agent and Controls Contractor, after Substantial Completion, after TAB and Cx Reports are submitted. The goal is to allow the CxA to confirm sample Cx checklists, and sample TAB readings.

.4 Within 9 months of Substantial Completion, MCxC, ECxC, MCA, ECA,TAB Agent shall visit site for verification of performance in all seasons and load conditions.

.2 After approval, incorporate Cx Schedule into Construction Schedule.

.3 Consultant, Contractor, Contractor's Cx agent, and Commissioning Authority will monitor progress of Cx against this schedule.

1.17 CX REPORTS

.1 Submit reports of tests, with samples witnessed and reviewed by Commissioning Authority and Consultant.

.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 Commissioning Authority and Consultant.

1.18 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 and electrical systems.

.2 Adjustment of ventilation rates to ensure adequate code ventilation and cooling of electrical equipment.

1.19 TRAINING PLANS

.1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.

1.20 FINAL SETTINGS

.1 Upon completion of Cx to satisfaction of Commissioning Authority, 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 Systems to be Cx'd

.1 The proposed system is generally comprised of the following:

.1 Space Heat (Zone Heating Control Valves)

.2 Ventilation/Motors/Drives (Ridge Vents).

.3 Specialized Greenhouse Controls:

.2 The Contractor shall use the 5 phase Cx process and document the proper operation of these systems, and the sub-systems they depend on, at least.

.3 This plan, or any other commissioning document or correspondence, does not relieve contractors from other testing, verification and commissioning duties that may be described in the project specifications or other agreements.

3.2 CxA's Duties

.1 The Commissioning Authority (CXA) serves as an objective advocate for the Owner, oversees the commissioning process and presents final recommendations to the Owner regarding the performance of the commissioned building. Avalon Energy Management (Contact Bob Landell) will perform the following tasks:

.1 Support efforts to implement the Building Systems Commissioning requirements throughout the project.

.2 List all relevant features and systems included in the Commissioning scope. The designers and contractors are to provide the detailed equipment lists, checklists, and schedules.

.3 Review the Owner's requirements and basis of design.

.4 Help coordinate the commissioning-related activities of the "Commissioning Team".

.5 Review the Contract Documents to help verify inclusion of commissioning responsibilities.

.6 Review Contractor's testing plans and criteria for each of the 5 Cx Phases

.7 Organize and chair Cx meetings of the Commissioning Team; facilitate the process of distributing minutes to all Commissioning Team members as required.

.8 Monitor construction for commissioning-related installation issues.

.9 Review start up process by observing a sampling of measurements.

.10 Verify commissioning process of automatic control systems by:

.1 Observing a sampling of point to point checks

.2 Obtaining and reviewing a copy of installation end-to-end check sheets.

.3 Observing a sampling of actuator travel ranges

.4 Observing a sampling of sensor calibration

.5 Observing a sampling of controls functional response

.6 Reviewing sample trend logs

.7 Verifying documentation of the testing of control sequences under all operating modes.

.11 Verify the documentation of performance of all systems being commissioned and witness a sample of functional performance tests, and review whether the results meet test criteria.

.12 Verify reported Testing and Balancing results by observing a sampling of measurements.

.13 Review consultant-approved Operating and Maintenance Manuals for compliance with specified content.

.14 Review seasonal testing by contractors, and carry out warranty year duties.

.15 Compile a commissioning report in accordance with the requirements.

3.3 General Contractor`s Duties

.1 The General Contractor shall ensure that the following Cx procedures and tests are within the scope of appropriate trades and sub-trades, and that they are performed and documented as required to meet the Owner's Project Requirements:

System	PRE-START	STARTUP	MANUF START RPT	TAB	FUNCTIONAL PERFORMANCE	VALIDATION & VERIFICATION
Heating	□	□	□	□	□	□
Cooling	□	□	□	□	□	□
Ventilation	□	□	□	□	□	□
Controls	□	□	□	□	□	□

Light delivery	□	□	□		□	□
Lighting controls	□	□	□	□	□	□
Power distribution Systems	□	□	□	□	□	□

.2 General Contractor will select independent Commissioning Agents and/or Coordinators to ensure Cx activities are carried out to ensure delivery of a fully operational project including:

.1 Organizing Cx.

.2 Monitoring operations Cx activities.

.3 Review of Cx documentation from operational perspective.

.4 Review for performance, reliability, durability of operation, accessibility, maintainability,

.5 Operational efficiency under conditions of operation.

.6 Protection of health, safety and comfort of occupants and O&M personnel.

.7 Monitoring of Cx activities, training, and development of Cx documentation.

.8 Work closely with members of Cx Team.

.9 Certifying accuracy of reported results

.10 Certifying tabs and other results

.11 Developing BMM.

.12 Ensuring implementation of final Cx Plan.

.3 The General Contractor shall incorporate the mechanical and electrical Cx schedules into the project's construction schedule, and coordinate milestones with the CXA.

.4 The General Contractor shall oversee or delegate the preparation for testing and Cx. The following are examples:

DYNAMIC TEST READINESS CHECKLIST

	YES	NO	N/A	DATE	INITIALS
GENERAL					
Applicable tests such as duct/pipe pressure tests submitted					
Construction, painting, millwork and flooring complete in areas served					
Work area clean and ready for fan start-up; "All Clean" declared					
AIRSIDE MECHANICAL					
TAB contractor has reviewed the system and completed job preparation					
Ductwork complete, terminals installed, dampers open					
Duct and fan plenum cleaning complete					
Correct filters installed					
Piping complete, gauges installed					
Piping filled, tested, treated and documented					
Valves positioned for testing					
Equipment mounts complete, shipping bolts removed, vibration isolation active					
Equipment lubricated					
Manufacturer's start-up reports received					
PLUMBING & WATERSIDE MECHANICAL					
Drainage connected					
Piping systems flushed out and treated					
Air removed from the system					
DHW systems activated					
CONTROLS					
Control wiring complete					
Control panels mounted and connected					
Thermostats, sensors, actuators, etc. installed					
End-to-end checks completed					
POWER					
Permanent electrical connections complete, including power to starters, rotation checks and overload sizes and settings checked					
Fire alarm system as per ULC					
Exit lighting					

Data and communications cabling systems					
Other tests and checks cited herein					

VERIFICATION READINESS CHECKLIST

	YES	NO	N/A	DATE	INITIALS
MECHANICAL					
Balancing complete					
Drive changes complete (as required)					
Applicable inspections by authorities having jurisdiction received					
CONTROLS					
Control program installed, and verification checklist or de-bugging documentation completed with changes noted. Major changes copied to consultant for review					

.5 The General Contractor shall ensure that Training Plans are developed by the appropriate trades and sub-trades, and that they are submitted to the Architect for review. See section

.6 The General Contractor shall ensure that Seasonal and Deferred Testing is performed and documented by the appropriate trades and sub-trades, and that the reports are submitted to the CxA for review.

3.4 The Commissioning Agent is responsible for:

.1 Witnessing reported results.

.2 Witnessing TAB and other tests.

.3 Provides basis of design data not included in the Contract Documents.

.4 Prepares an equipment inventory and all functional testing criteria and checklists, as required by the specification and Commissioning Plan for all features and systems requiring commissioning.

.5 Reviews commissioning checklists and test forms to ensure applicability to the project and provide comments to the Commissioning Authority.

.6 Attends commissioning activities as required to certify the site adaptation and related work meet the design intent and the project requirements.

3.5 Facility Manager: represents lead role in Operation Phase and onwards and is responsible for:

.1 Receiving facility on completion.

.2 Day-To-Day operation and maintenance of facility.

3.6 Mechanical Contractor`s Duties

.1 The Mechanical Commissioning Agent (MCA) shall be engaged by the Mechanical Trade Contractor to execute the requirements set out by the CaGBC's documentation, and the Contract Documents. The Commissioning Agent shall perform the following tasks:

.1 Prepare an MCA's Commissioning Plan outlining each of the following five phases involved in the Cx process:

.1 Phase 1 - System readiness.

.2 Phase 2 - System start-up, testing, balancing, and adjustment.

.3 Phase 3 - Verification of system performance.

.4 Phase 4 - Demonstration and instruction.

.5 Phase 5 – Seasonal testing and verification.

.2 Prepare an equipment inventory and all functional testing criteria as required by the specifications and Commissioning Plan for all features and systems requiring commissioning.

.3 Submit all required testing documentation to the Commissioning Authority and Mechanical Consultant for review.

.4 Attend all commissioning meetings as required by the Commissioning Authority or Owner.

.5 Execute or delegate all commissioning tasks as set out in the final functional testing criteria documents.

.6 Coordinate with Trade Contractors regarding sequencing of work. For example, before manufacturer site start-up of AHUs, safety features must be in place, ductwork must be ready, "All Clean" must be declared, power must be connected, hydronics must be cleaned, filled and free of air, controls must have been tested, etc.. Manufacturer start-up must be done prior to air balance, and so on.

.7 Record and document the verification of the specified Pre-Start checks, including but not limited to the following:

Compliant make and model,
CSA label,
no visible damage,
proper equipment installation as per specifications and manufacturer's recommendations,
mounting as specified,
seismic restraint as specified,
electrical connection safe and complete,
safety controls & interlocks functional,
operating controls connected and adequately functional,
pre-start safety checks (where applicable),
connection of other services complete,
supporting or related systems in place,
access for maintenance in place,
strainers/filters clean and firmly in place,
isolation valves, dampers or switches in place, set correctly and functional,
alignment of drives and components correct,
proper coil drain pan draining,
bypasses in place and appropriately positioned open or closed,
vibration isolation adjusted,
insulation as specified and full coverage,
lubrication complete,
penetrations through fire separations in place as specified,
purges and pressure/leak tests complete and passed,
environment (cleanliness, clearance, cooling, drainage, freeze protection, etc.) good,

water tightness of mechanical service roof and exterior wall penetrations,
air and water distribution cleaned degreased,
charges & pressures correctly set; proper air and water pressure relief in place.

.8 Record and document the verification of the specified Startup checks, including but not limited to the following:

pre-start test passed and conditions still in effect,
qualified personnel present,
confirmation of regulatory authorities' inspections, including reports,
manufacturer or vendor representative present,
factory technician test and start-up (where applicable),
correct rotation,
safety controls operate properly,
operating controls function properly
sequencing correct,
desired temperature/pressure/humidity maintained,
electrical characteristics conform to ratings,
no leaks,
noise as per ratings,
obtain certificates of approval and for compliance with regulations from Authorities Having Jurisdiction; include copies of certificates with startup reports.

.9 Immediately after start-up, submit Pre-start checklists and Start-up checklists, signed by the person performing the start-up, to the CxA.

.10 Prepare Functional performance test checklists containing the step-by-step procedures by which the functional requirements of a system, and its various components, will be confirmed. System's response is to be verified and clearly documented according to the respective manufacturer's written instructions, this plan, and the Contract Documents.

.11 The MCA is to prepare Functional Performance Test Checklists, including but not limited to the following:

.1 individual test procedures,

.2 the expected system response or acceptance criteria for each procedure,

.3 a place to record the actual response or findings,

.4 comments pertinent to the ongoing performance of the system and building.

.12 Each control sequence and strategy shall be tested, verified and documented by the Contractor, including:

.1 start-up, and shut down,

.2 modulation up and down over unit's range of capacity, and/or component staging,

.3 unoccupied and manual modes,

.4 power failure and backup/restart,

.5 abnormal or emergency modes,

.6 interlocks and alarms,

.7 sensor calibration.

.13 The checklists are to confirm the Owner's Project Requirements and design intent with respect to the following:

.1 electrical characteristics

.2 flows,

.3 pressures,

.4 temperatures

.5 overall system control programming and automatic performance and alarms.

The goal is to determine whether the installation functions properly under all specified conditions, not that it can be shown to function under one condition. Functional Performance Checklists, signed by the person performing the tests, must be submitted to the CxA immediately after testing.

.14 Participate in troubleshooting those systems that do not meet the functional testing criteria and provide all necessary follow-up testing and documentation.

.15 Submit completed functional test documentation to the Commissioning Authority and Mechanical Design Consultant for inclusion into the final Commissioning Report.

.16 Within 2 months of award, provide a preliminary Cx schedule for pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion to the Project Manager and the CXA. Update the schedule as appropriate. Submit information to the Project Manager on a monthly basis to refine the schedule for the commissioning phase of the work. Provide the following information:

.17 Building "All Clean"

.18 Equipment start-up schedule.

.19 Submission dates for the various documents required prior to substantial performance.

.20 Timing of the various phases of the commissioning, testing, balancing and training/demonstration process.

.21 Provide a certificate of building cleanliness: An "All Clean" declaration is to be signed by the Architect, Mechanical Engineer, and General Contractor. It shall signify that the building and ductwork is adequately clean to allow air distribution start-up without contaminating coils, controls, fan chambers, etc.

.22 Provide regular updates on project progress, of and witnessing of Cx. MCA to contact Avalon prior to Cx, and to provide 48 hours' notice of tests.

.23 Provide a Commissioning Report as specified in the contract documents and herein.

.24 Plan, coordinate and execute Owner and Building Operator training and demonstrations as set out in the specifications and Commissioning Plan.

.25 Provide two follow-up site visits to re-test and verify occupancy and seasonal-sensitive systems after the facility has been fully occupied. Coordinate seasonal performance verification with CxA. Tests must be done during normal (high) occupancy working hours,

and at near winter design conditions, and near summer design conditions. Cx Agent shall review equipment operation, status of energy saving strategies. Submit a report of findings to CxA for each visit. Report to contain the following:

.1 Verification of whether conditions meet the Owner Requirements (as documented by Cx Authority), and whether equipment performance meets the design intent.

.2 List of out-of-tolerance conditions, and malfunctioning equipment, components and systems.

.3 Recommendations addressing each problem that was identified.

Seasonal Test Report – **Mechanical Cx Agent -** Required Sections:

WINTER	**SUMMER**
Date: Time of visit: Outdoor Temperature: Outdoor Cloud Cover: Areas too hot: Areas too cold: Areas Humidity: Areas With High Noise:	Date: Time of visit: Outdoor Temperature: Outdoor Cloud Cover: Areas too hot: Areas too cold: Areas Humidity: Areas With High Noise:
Air distribution equipment operating properly: Occupant Concerns Operator Concerns	Air distribution equipment operating properly: Occupant Concerns Operator Concerns
Owner Requirements being met for plumbing. List of Equipment Functioning Improperly **Problems:**	*Owner Requirements* being met for plumbing. List of Equipment Functioning Improperly **Problems:**
1 Description: Solution: Recommendation:	1 Description: Solution: Recommendation:
2 Description: Solution: Recommendation:	2 Description: Solution: Recommendation:
3 Description: Solution: Recommendation:	3 Description: Solution: Recommendation:

.26 Depending on the details of the contractors' contracts among themselves, either the Mechanical Cx Agent, or the mechanical trade shall provide further Seasonal Testing as follows:

Seasonal Test Report – **Mechanical Contractor** Required Sections

Six Months After Occupancy

Date:
Time of visit:
Outdoor Temperature:
Outdoor Cloud Cover:
Areas too hot:
Areas too cold:
Areas Humidity:
Areas With High Noise:

Air distribution equipment operating properly:

Filters not bypassing and clean
Vibration/noise acceptable
Leaks found and plugged
Warranty Issues

Owner Requirements being met (details)

List of Equipment Functioning Improperly

Problems:

1	Description: Solution: Recommendation:
2	Description: Solution: Recommendation:
3	Description: Solution: Recommendation:

.27 Provide a report, for inclusion in the Re-commissioning Manual, which describes problems, solutions, and suggested improvements revealed in the first months of operation (Word and Excel format).

3.7 Testing & Balancing Agent Duties

.1 The Testing and Balancing Agent (TAB) shall be engaged by the Mechanical Trade Contractor to execute the contract requirements to meet the design intent and the Commissioning Authority. The TAB Agent must perform the following tasks:

.1 Prepare all functional testing criteria (including specific documentation) as required by the Commissioning Plan for all features and systems requiring testing or balancing.

.2 Submit all required testing documentation to the Commissioning Authority and Mechanical Consultant for review, including schedule, proposed procedures, and sample forms.

.3 Visit the site prior to TAB to review adequacy (quantities, locations and types) of balance-related devices.

.4 Attend all commissioning meetings as required by the Commissioning Authority.

.5 Provide Avalon with 7 days' notice of TAB testing periods.

.6 Execute or delegate all TAB tasks as set out in the final functional testing criteria documents.

.7 Coordinate with trade contractors regarding sequencing of work. For example, before balancing, ductwork must be ready, safeties must be functioning, power must be connected, hydronics to be filled and free of air, controls to have been tested, and, in the case of air distribution, the "All Clean" status must have been granted. Manufacturer start-up must be done prior to air balance, and so on.

.8 Provide the following TAB Process Quality Assurance Review to the CxA 2 months prior to commencement of balancing:

PROJECT: **PFC Greenhouse Energy Management System**
DATE: (Month) 16

	Test process	Test Equip	Equip Calibration	Test Staff	Staff Experience	Pass/Fail Criteria
AHU CFM			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	+/- X% from spec
Max/Min OAD Volumes			Certificate from X dated X	Ms Jane Doe	X yr; X projects; Qualifications	+/- X% from spec
Fan Flows			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	+/- X% from spec
Vent Flows			Certificate from X dated X	Ms Jane Doe	X yr; X projects; Qualifications	+/- X% from spec
Pump Flows			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	+/- X% from spec
Heat Terminals			Certificate from X dated X	Ms Jane Doe	X yr; X projects; Qualifications	+/- X% from spec
Cooling			Certificate from X dated X	Mr John Doe	X yr; X projects; Qualifications	heat, cool, air change, OA CFM, controls

.9 At the completion of balancing, and following review of the TAB report, visit the site with the CxA and retest a sampling of balanced air. The CxA could require that up to 5% of terminals be verified, depending on the results of initial tests.

.10 Participate in troubleshooting those systems that do not meet the functional testing criteria and provide all necessary follow-up testing and documentation.

.11 Submit completed functional test documentation to the Commissioning Authority and Mechanical Design Consultant for inclusion into the final Commissioning Report.

.12 Provide O&M Manuals as specified. Provide sections of O&M Manual for inclusion in Systems Recommissioning Manual to CxA, in Word and Excel file format, as required.

.13 Plan and execute demonstrations and training as set out in the Commissioning Plan or specifications.

.14 Provide deferred or seasonal functional performance testing and documentation of proper operation during warrantee period. Seasonal test to be done so that systems' performance is reviewed during both warm (summer) days and cold (winter) days. Correct deficiencies and make necessary adjustment to O&M manuals and as-built drawings.

3.8 Seasonal Test Report – TAB Agent- Required Sections:

Three, Six or Nine Months After Occupancy

Date:
Time of visit:
Outdoor Temperature:
Outdoor Cloud Cover:

Areas too hot:
Areas too cold:
Areas Humidity:
Areas With High Noise:

Air distribution equipment operating properly:
- Motor rotation
- Volumes still as per design intent
- Supply Air & water temperatures appropriate and efficient
- Outdoor Air volumes minimal for heating, max for free cooling

Flow and ventilation Owner Requirements being met (details)

List of Equipment Functioning Improperly

Problems:

1	Description: Solution: Recommendation:
2	Description: Solution: Recommendation:
3	Description: Solution: Recommendation:

3.9 Controls Contractor Duties

.1 The Controls Trade Contractor shall provide a Commissioning Agent (CCA) from their staff to:

.2 Prepare a CCA's Commissioning Plan outlining each of the following five phases involved in the Cx process:

- .1 Phase 1 - System readiness (clean, grounded, interlocked, mounted properly, accessible, etc.).
- .2 Phase 2 - System start-up, testing, balancing, and adjustment.
- .3 Phase 3 - Verification of system performance.
- .4 Phase 4 - Demonstration and instruction.
- .5 Phase 5 – Seasonal testing and verification.

.3 Prepare Functional Performance Test Checklists to record that all controls provided have been inspected, checked and verified for proper installation and performance. Prepare an equipment inventory and all functional testing criteria as required by the specifications and Commissioning Plan for all features and systems requiring commissioning. Example checklists are as follows:

CONTROLLERS	**Controller**	**Card**	**Card**
ITEM INSPECTED	1	**Expansion Module 1**	**Expansion Module 2**
	Y/N/na	Y/N/na	Y/N/na
Shop drawings approved			
Software licensing in place			
QC inspection report reviewed and deficiencies corrected			
Device matches specified products			
Devices mounted and restrained properly			
Number of control panels & system architecture correct			
Number of points monitored is correct			
Conduit, plenum-rated cable and flex connections selected and installed appropriately			
Wire shielding is correct			
Control device properly located and installed			
Devices and components tagged and identified at all terminations, splices, and junctions			
Point lists present inside panel			
Software and hardware alarms are in place			

CONTROLLERS	**Controller**	**Card**	**Card**
ITEM INSPECTED	1	**Expansion Module 1**	**Expansion Module 2**
	Y/N/na	Y/N/na	Y/N/na
Connection to EMCS Server DDC network is made (if req'd)			
Graphics accepted by ME & Owner			
BACnet interface between proprietary controls and DDC system are functioning properly			
Trend-log in place for all necessary inputs, outputs, variables			
Operating software complete, including control strategies, alarms, trends, etc..			
REMARKS/COMMENTS:			
ACKNOWLEDGED			
Controls Contractor:			
MCA:			

INPUT POINTS	**Card**	**Inputs**	
ITEM INSPECTED	**1**	1ip1	1ip2
		Y/N/na	Y/N/na
Shop drawings approved			
QC inspection report reviewed and deficiencies corrected			
Devices matches specified products			
Devices mounted and restrained properly			
Number of points monitored is correct			
Conduit, plenum-rated cable and flex connections selected and installed appropriately			
Wire shielding is correct			
Control device properly located and installed			
Sensors and devices calibrated and verified			
Devices and components tagged and identified at all terminations, splices, and junctions			
Trend-log in place for all necessary (inputs, outputs, variables)			
REMARKS/COMMENTS:			
ACKNOWLEDGED			
Controls Contractor:			
MCA:			

OUTPUT POINTS	**Card**	**Outputs**	
ITEM INSPECTED	**1**	1OP1	1OP2
	Y/N/na	Y/N/na	Y/N/na
Shop drawings approved			
Sequences of operation are understood and make sense			
Compartment Heating			
Low level heating (by pumps and HCVs) in response to Room Temp, OAT, Light Intensity, Wind Speed, Wind Direction, Rain			
High level Heating			
Room temp alarms (high and low)			
Water temp alarms (low)			
Corridor Heating			
HCV operates in response to room temp			
Compartment Ventilation in response to Room Temp, Room RH, OAT, Light Intensity, Wind Speed,			
Leeward and Windward Vents			
Destratification Fans			
Side Vents			
Coolers			
Vent response alarm			
Compartment Humidity			
CV operates in response to room RH or Wet Bulb			
Humidity alarms (range and function)			
Light Level Control in response to Light Meter; Thermal and Solar Energy Strategies			
Light control			
Shading Curtains			
Blackout Curtain			
Each control sequence and strategy shall be listed and tested, verified and documented by the Contractor, including:			
start-up, and shut down,			
modulation up and down over unit's range of capacity, and/or component staging,			
unoccupied and manual modes,			
power failure and backup/restart,			

abnormal or emergency modes,			
interlocks and alarms,			
QC inspection report reviewed and deficiencies corrected			
Devices matches specified products			
Devices mounted and restrained properly			
Conduit, plenum-rated cable and flex connections selected and installed appropriately			
Wire shielding is correct			
Control device properly located and installed			
Sensors and devices calibrated and verified			
Devices and components tagged and identified at all terminations, splices, and junctions			
Software and hardware alarms are in place			
BACnet interface between proprietary controls and DDC system are functioning properly			
Trend-log in place for all necessary (inputs, outputs, variables)			
REMARKS/COMMENTS:			
ACKNOWLEDGED			
Controls Contractor:			
MCA:			

.4 Submit all required testing documentation to the Commissioning Authority and Mechanical Consultant for review.

.5 Attend all commissioning meetings as required by the Commissioning Authority or Owner.

.6 Execute or delegate all commissioning tasks as set out in the final functional testing criteria documents.

.7 Verify that systems are functionally meeting the design intent, and produce a Cx Report documenting this, and identifying where design intent is not being met.

.8 Controls Contractor to provide O&M Manual, including sequences of operation, network diagrams, graphics, shop drawings, recommended post-occupancy calibration, test and maintenance procedures, etc. to CXA for inclusion in Systems Recommissioning Manual. Submit in Word and Excel file format, as required.

.9 Controls Contractor to provide training and training materials for temperature controls, DDC operation and reporting, energy conservation strategies, and other control items having an impact on building or system operation.

.10 Provide deferred or seasonal functional performance testing and documentation of proper operation during warrantee period. Seasonal test to be done during normal working hours, and so that systems' performance is reviewed during both warm (summer) days and cold (winter) days. Correct deficiencies and make necessary adjustment to O&M manuals and as-built drawings.

Seasonal Test Report – **Controls Contractor -** Required Sections:

Three, Six or Nine Months After Occupancy

Date:
Time of visit:
Outdoor Temperature:
Outdoor Cloud Cover:

Areas too hot:
Areas too cold:
Areas Humidity:
Areas With High Noise:

Control system operating properly: Sequences in "auto"
Weather station sensing and reporting is operating in accordance with design intent
Minimal simultaneous heating and cooling
Each compartment low level and high level heating functions as per design intent
Dampers operating properly
Light level shades meeting design intent
Blackout shades meeting design intent
Each compartment humidity control performing as per design intent
Each compartment cooling and ventilation performing as per design intent
Motor speeds no higher than necessary
Lighting interface and unoccupied sweeps functioning
Time Schedules correct

Owner Energy and Temp Control Requirements being met (details)

List of Equipment Functioning Improperly

Problems:

1	Description: Solution: Recommendation:
2	Description: Solution: Recommendation:
3	Description: Solution: Recommendation:

3.10 Electrical Trade Contractor Duties

.1 The Electrical Trade Contractor shall provide a Commissioning Agent or Coordinator (ECA) to

- .1 Prepare an ECA's Commissioning Plan outlining each of the following five phases involved in the Cx process:
  - .1 Phase 1 - System readiness (clean, grounded, interlocked, mounted properly, accessible, etc.).
  - .2 Phase 2 - System start-up, testing, balancing, and adjustment.
  - .3 Phase 3 - Verification of system performance.
  - .4 Phase 4 - Demonstration and instruction.
  - .5 Phase 5 – Seasonal testing and verification.
- .2 Conduct and pay for tests of the following:
  - .1 Low voltage breaker set-up, calibration, testing and reporting.
  - .2 Testing protection and control DC supply, voltage, current and wiring systems.
  - .3 Transformer testing and commissioning
  - .4 Voltage testing
  - .5 Phase rotation testing
  - .6 Lighting systems and controls
  - .7 Such additional testing as required for completion of the test forms laid out in 01 91 31 3.9.24
- .3 Furnish manufacturer's certificate or letter confirming that entire installation relating to their product has been installed to manufacturer's instructions.
- .4 Carry out tests in presence of the Commissioning Authority.
- .5 Give advance notice of proposed time of tests so that the Commissioning Authority can be represented at the tests.
- .6 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .7 Submit test results for review by the Commissioning Authority.
- .8 Test all systems in accordance with details in appropriate sections.
- .9 Testing methods and test results: in accordance with CSA, CEC, NETA MTS, and regulations of the supply authority and other authorities having jurisdiction.
- .10 Liability: During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.
- .11 Remove and replace with new materials all conductors that are found to be shorted or grounded.
- .12 Conduct dielectric tests, hi-pot tests, insulation resistance tests and ground continuity tests as required by the nature of the various systems and equipment.

.13 With the systems completely connected and lamped, conduct and document the following tests on the power system:

.1 Control and Switching: test all circuits for the correct operation of devices, switches and controls.

.2 Polarity Tests: test all circuits for correct operation of devices, switches and controls.

.3 Voltage Tests: make a voltage test at the last outlet of each circuit. Maximum drop in potential permitted will be 2% on 120V, and 208V branch circuits. 2% on 208V feeder circuits, and 5% on 600V feeder circuits. Correct any deficiency in this respect.

.4 Phase Balance: measure the load on each phase at each switchboard, splitter, distribution panel board and lighting and power panel board. Report results in writing to the Commissioning Authority. Re-arrange phase connections as necessary to balance the load on each phase as instructed by the Commissioning Authority with the re-arrangement being restricted to the exchanging of connections at the distribution points mentioned in this paragraph. After marking any such changes, make available to the Commissioning Authority, drawings or marked prints showing the modified connections.

.5 Supply Voltage: measure the line voltage of each phase at the load terminals of the main breakers and report the results in writing to the Commissioning Authority. Perform this test with the majority of electrical equipment in use.

.6 Motor Loading: measure the line current of each phase of each motor with the motor operating under load and report the results in writing to the Commissioning Authority. Upon indications of any imbalance or overload, thoroughly examine electrical connections and rectify any defective parts or wiring. If electrical connections are correct, overloads due to defects in the driven machines shall be reported in writing to the Departmental Representative. Verify motor full load amps and overload relays are properly sized and adjusted accordingly.

.7 General Operations: energize and put into operation each and every electrical circuit and item. Make repairs, alterations, replacements, tests and adjustments necessary for a complete and satisfactory operating electrical system.

.14 Carry out tests covering "General Operation" at the time of acceptance of the work.

.15 Test all systems and obtain written confirmation from the manufacturer of each system that all components have been installed correctly and that the system is functioning as intended. Present separate certification for all systems including: fire alarm, power distribution, to the Commissioning Authority.

.16 Provide labour, instruments, apparatus and pay all expenses required for the tests. The Departmental Representative reserves the right to demand proof of the accuracy of all instruments used.

.17 When tests are performed, the Departmental Representative may require that equipment be opened and removed from their housings to examine interior of equipment, terminations and connections. Provide all required labour and tools.

.18 Co-ordinate the testing of motors with the trades providing the equipment driven by the motors so that they are carried out at the time the driven equipment is put on test. In addition to the motor loading tests, provide labour and instruments to take and record all motor load readings required to supplement the tests on the driven equipment through various load sequences, as required by the trades involved.

.19 Immediately prior to building occupancy, test the entire electrical system by performing a loss and return of utility power test. Demonstrate the operation of:

.1 High and low voltage service equipment and metering.

.2 Exit and emergency lighting.

.3 Fire alarm operation during power outage, including remote monitoring system.

.4 EMCS system shut down and auto restart, including re-stabilization of systems after power return. Attach printouts as evidence of expected operation on all systems including all air handling systems and pump systems.

.5 User equipment shutdown and auto-restart.

.1 On completion of the inspection and when all of the above conditions have been complied with, the manufacturer shall issue to the Commissioning Agent the following:

.1 A copy of the inspecting technician's report showing the location of each device and certifying the test results of each device.

.2 A certificate of verification confirming that the inspection has been completed and showing the conditions upon which such inspection and certification have been rendered.

.3 Proof of liability insurance for the inspection.

.2 Verification procedures, testing requirements, documentation required, etc. shall be in accordance with the requirement of ULC Standard CAN/ULC-S537.

.3 The Commissioning Agent must be present at and during the verification and certification in order for the verification to be valid.

.4 Start-up:

.1 The verification and certification hereinafter described shall include the following tests:

.1 Initiate alarm from each manual pull station.

.2 Initiate alarm from each automatic heat and/or smoke detector by operation of device or by jumpering out device in the case of fixed temperature heat detectors

.3 Initiate alarm at control panel to check supervisory function.

.4 Initiate one test alarm to central supervisory station after notice of test is given.

.5 Check correctness of identification of annunciator zones for each device.

.6 Check operation of all auxiliary contacts and devices and verify that auxiliary control of door holders, fans, etc. is fully operational.

.7 Above noted system shall be compatible with Base system.

.8 After verification of the fire alarm system, demonstrate the system to the satisfaction of the Commissioning Authority.

.20 Prepare Functional Performance Test Checklists that will be a record that all electrical services provided have been inspected, checked and verified for proper installation and performance. Prepare an equipment inventory and all functional testing criteria as required by the specifications and Commissioning Plans for all features and systems requiring commissioning. Note: there may be Cx requirements in other sections of the specification.

.2 Submit all required testing documentation to the Commissioning Authority and Electrical Consultant for review. For example:

.1 Implementation of Coordination Study Settings

.2 Certificates and/or Equipment Test Report

.3 Equipment Spare Parts Report

.4 Generic Acceptance Report

.5 Final Acceptance Report.

.3 Attend all commissioning meetings as required by the Commissioning Authority or Owner.

.4 Execute or delegate all commissioning tasks as set out in the final functional testing criteria documents.

.5 Verify that systems are functionally meeting the design intent, and produce a Cx Report documenting this, and identifying where design intent is not being met.

.6 Electrical Trade Contractor to provide O&M Manual, sequences of operation, recommended post-occupancy calibration, test and maintenance procedures, etc. to CXA for inclusion in Systems Recommissioning Manual. Submit in Word and Excel file format, as required.

.7 Electrical Trade Contractor to provide training and training materials

.8 Provide deferred or seasonal functional performance testing and documentation of proper operation during warrantee period. Seasonal test to be done during normal working hours, and so that systems' performance is reviewed during both long (summer) days and short (winter) days. Correct deficiencies and make necessary adjustment to O&M manuals and as-built drawings.

.9 Allow minimum 8 hours for each of two site visits for seasonal/deferred testing and reporting. 16 hours total.

Seasonal Test Report – **Electrical Contractor & Cx Agent** - Required Sections:

Three to Nine Months After Occupancy

Date:
Time of visit:
Outdoor Temperature:
Outdoor Cloud Cover:

Areas too dark:
Areas too bright:

Lighting
Interior light levels after sundown Occupancy sensors function Dimming system function Time Schedules (unocc sweeps) Emergency lights Exterior light coverage, and Dark Sky Protection
Power equipment operating properly: Labelling and cleanliness Metering accuracy (believable kW, V, A, PF) Breakers holding Motor starters in Auto Power quality still good; phase output, phase to phase output, power factor, etc. acceptable Line voltage controls by Elect operating properly Time Schedules, including daylight savings offset

Owner Requirements for lighting and energy being met (details)

List of Equipment Functioning Improperly

Problems:

1	Description:	Solution: Recommendation:
2	Description:	Solution: Recommendation:
3	Description:	Solution: Recommendation:

3.11 Required Written Work Products – Consultants, and Trades Other Than Cx Agencies, Controls and Electrical

.1 COMMISSIONING AUTHORITY

.1 Schematic design review.

.2 CxA'S Cx Plan (this document),

.3 Review of construction documents,

.4 Commissioning Binder, Systems Manual and 10 Month Warranty Report.

.2 DESIGN CONSULTANTS

.1 Contract Documents by consultants. The Consultants' (Architect, Designers and Engineers) Contract Documents shall clearly require that features, equipment and systems are to be installed in such a way that TAB and commissioning are facilitated. The documents shall also identify Trade Contractors' responsibilities for execution and documentation of the Commissioning Process.

.2 Shop drawing process:

.1 The contractor is to forward the shop drawings, via architect, to the consultants, who review them.

.2 The architect shall forward mechanical, electrical and lighting shop drawings to the CxA at the same time as the engineers.

.3 All Change Orders and Site Instructions are to be copied to the CxA. Consultants to verify that changes are in keeping with the Owner's Project Requirements.

.4 Reviews and approvals of insulation, air barrier, walls, windows, roof and skylights by Architect or envelope consultant to document that envelope assemblies control water and air leakage, and condensation properly - so that negative impact on energy required is minimized, and negative impact on IAQ is eliminated. CXA to receive copies of all such Field Reviews and test reports.

.5 Training overview material is required from the Architect, including how the building keeps air and water out; what kind of envelope maintenance may be required and when; unusual items, etc. Design intents are required from the mechanical and electrical engineers.

.6 Reviews and acceptance of electrical power and lighting components and of proper system installation and operation, provided by Electrical Engineer.

.7 Reviews and acceptance of mechanical components, and of proper system installation and operation, to be provided by Mechanical Engineer.

.8 Building "All Clean" certification is required to allow fan operation. The Architect, General Contractor and Owner shall jointly sign a letter declaring that the building and systems are clean enough to run the fans.

.9 Reviews of TAB and commissioning submittals and documents by Design Consultants, with written acceptance forwarded to the CXA for inclusion in the Commissioning Report.

.3 TRADE CONTRACTORS

.1 Construction Schedule integrating all divisions of the work, and allowing adequate time for submittal reviews, commissioning of equipment, verification of systems' operation, and the demonstration to (and training of) the Owner, review of operating and maintenance and Cx manuals. The schedule shall include, but not be limited to, the following items:

.1 Installation and testing of piping systems and equipment, including protection of heat exchangers during cleaning.

.2 Installation and cleaning of air distribution systems and equipment.

.3 Connection of electrical services to equipment by electrical trade contractor.

.4 Chemical cleaning and treatment of water distribution systems.

.5 Control system installation.

.6 Pre-start checks.

.7 Start-up of equipment and systems.

.8 Air/Water balancing, including samples witnessed by CXA.

.9 Check-out of control systems.

.10 Commissioning of systems, including samples witnessed by CXA.

.11 Correction of deficiencies and retests.

.12 Demonstration of systems and equipment to Consultant.

.13 Demonstration of systems and equipment to Owner.

.14 Preparation of maintenance manuals and as-built drawings.

.15 Submission of the various documents required prior to substantial performance.

.16 Project closeout documents.

.2 Contractor Submittal Drawings and Equipment Data: Submittals will be reviewed by Design consultants and CXA to help verify that the systems and equipment being supplied are consistent with the required commissioning test procedures, and if not, that the variances are acceptable to the Team, and that commissioning checklists are revised accordingly.

.3 Approved Pre-start checklists and Start-up checklists must be completed prior to start-up of each specific system or piece of equipment. Checklists, signed by the person performing the start-up, must be submitted to the CXA immediately after start-up.

.4 Functional performance verifications for equipment and systems must be performed, and redone until proper system performance is verified.

.5 As-built drawings forwarded by installing contractors. The various trades shall mark-up the consultants' drawings to indicate design or layout changes that took place during construction.

.6 Training materials by sub-trades to meet the requirements of See Section 01 91 41.

.7 Reports on seasonal testing and documentation of proper operation during warrantee period.

.8 See other sections for specific MCA, ECA, CCA, and TAB Trade requirements and duties.

.9 The following tables provides a <u>partial</u> checklist of submittals required by each sub-trade:

DESCRIPTION	FORMAT			FROM			
	PDF	.doc .xls	sign-off	Consultant	Cx Agent	TAB	Mech Contractor
Cx Plan (5 Phases), Process, Inventories and Checklists		☐			☐	☐	☐
Cx Schedule (5 Phases)		☐			☐	☐	☐
Preliminary O&M Manual from Cx Agents		☐			☐	☐	☐
Reviewed TAB Report	☐	☐		☐			
TAB Report Test Performance Sheets	☐	☐			☐	☐	☐
Reviewed O&M Manual	☐		☐	☐			
System Descriptions and all sections described in Contract Doc's	☐	☐			☐	☐	
Validation Of Testing and Balancing			☐		☐	☐	
Training Plans		☐			☐	☐	☐
Validation of Fire Damper Operation			☐		☐	☐	
Training Materials and Validation of Owner's Training	☐	☐	☐	☐	☐	☐	☐
Deferred & Seasonal System Tests, Adjustments and Reports	☐				☐	☐	☐

DESCRIPTION	FORMAT				
	PDF	.doc .xls	sign-off	Mech Contractor	Controls Contractor
Controls Cx Plan (5 Phases), Inventories and Checklists		☐			☐
Cx Schedule (5 Phases)		☐			☐
Preliminary O&M Manual from Cx Agents		☐		☐	☐
Signed Commissioning Checklists	☐	☐		☐	☐
DDC & Other Controls Sequences of Operation	☐	☐			☐
Controls Checkouts	☐	☐			☐
Recommended Post-Occ Calib, Test & Maint Procedures		☐			☐
Training Plan	☐	☐		☐	☐
Training Materials and Validation of Owner's Training		☐	☐	☐	☐
Seasonal System Tests, Adjustments and Reports		☐		☐	☐

DESCRIPTION	FORMAT			FROM
	pdf	.doc .xls	Sign off	Electrical Contractor
Cx Plan (5 Phases) Inventories and Checklists				☐
Cx Schedule (5 Phases)				☐
Preliminary O&M Manual from Cx Agents		☐		☐
Validation of Power Systems Operation			☐	☐
Reviewed Commissioning Report	☐	☐		
Start-up and Operation Requirements – Electrical Systems			☐	☐
Signed Commissioning Checklists	☐	☐		☐
Reviewed O&M Manual	☐		☐	☐
System Descriptions	☐	☐		
Reviewed Controls Manual	☐	☐		
Line Voltage Controls Checkouts	☐	☐		☐
Electrical Training Plan				☐
Validation of Penetrations Through Separations			☐	☐
Validation of Seismic Restraint Installation			☐	☐
Validation of Vibration Isolation			☐	☐
Validation of Electrical System Demonstration			☐	☐
Training Materials and Validation of Owner's Training	☐	☐	☐	☐
Problems & Suggestions in First Few Months		☐		☐
Seasonal System Tests, Adjustments and Reports	☐			☐

DESCRIPTION	FORMAT			FROM
	PDF	.doc .xls	sign-off	Electrical Trade
Cx Schedule (5 Phases)				☐
Power Shop Drawings	☐			☐
Electrical Training Plan	☐			☐
Validation of Fire Stopping	☐		☐	☐
Letters of Assurance from Trades' Engineers	☐			☐
Validation of Items To Be Handed Over To Owner	☐		☐	☐
Validation of Electrical System Demonstration	☐		☐	☐
Training Materials and Validation of Owner's Training	☐	☐	☐	☐
Record Drawings	☐	☐	☐	☐

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Commissioning forms to be completed for equipment, system and integrated system.

.2 Related Requirements

.1 Section 01 91 31 Cx Plan.

.2 Section 01 91 41 Cx Training.

1.2 INSTALLATION/START-UP CHECK LISTS

.1 Include the following data:

.1 Product manufacturer's installation instructions and recommended checks.

.2 Special procedures as specified in relevant technical sections.

.3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.

.2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Commissioning Authority, 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 Commissioning Authority. 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 Commissioning Authority's approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

.1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.

.2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.

.3 Prior to PV of integrated system, complete PV forms of related systems and obtain Commissioning Authority's approval.

1.5 SAMPLES OF COMMISSIONING FORMS

.1 Commissioning Authority will review project-specific Commissioning forms developed by the Contractor, in electronic format complete with specification data.

.1 HVAC.

.2 HVAC Controls

.3 Specialized Greenhouse Controls

.4 Power Systems – Normal power systems (breakers/ receptacles). No switchgear, back-up power or isolated power.

.5 Lighting & Lighting Controls – Interior lighting. No specialty lighting.

.2 Revise items on Commissioning forms to suit project requirements.

.3 Samples of Commissioning forms and a complete index of produced to date will be attached to this section.

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

.1 When additional forms are required, develop appropriate verification forms and submit to Commissioning Authority for approval prior to use.

1.7 COMMISSIONING FORMS

.1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.

.2 Strategy for Use:

.1 Contractor will provide required shop drawings information and Cx Pre-start, Start-up and Functional Performance Verification checklists and verify correct installation and operation of items indicated on these forms.

.2 Confirm operation as per design criteria and intent.

.3 Identify variances between design and operation and reasons for variances.

.4 Verify operation in specified normal and emergency modes and under specified load conditions.

.5 Record analytical and substantiating data.

.6 Verify reported results.

.7 Form to bear signatures of recording technician and reviewed and signed off by Commissioning Authority.

.8 Submit immediately after tests are performed.

.9 Reported results in true measured SI unit values.

.10 Provide Commissioning Authority and Consultant with originals of completed forms.

.11 Maintain copy on site during start-up, testing and commissioning period.

.12 Forms to be both hard copy and electronic format with typed written results in Building Management Manual in accordance with Section 01 78 00 – Closeout Submittals.

1.8 LANGUAGE

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 This Section specifies roles and responsibilities of Commissioning Training.

.2 Related Requirements

.1 General Commissioning Cx Requirements Section 01 91 13

.2 Section 01 91 31 Cx Plan.

.3 Section 01 91 33 Cx Forms.

1.2 TRAINEES

.1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.

.2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

.1 Commissioning Authority will provide:

.1 Descriptions of systems.

.2 Instruction on design philosophy, design criteria, and design intent.

.2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:

.1 Start-Up, operation, shut-down of equipment, components and systems.

.2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.

.3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.

.3 Contractor and equipment manufacturer to provide instruction on:

.1 Start-up, operation, maintenance and shut-down of equipment they have installed and connected, after completion of static verification, start-up and functional performance testing.

1.4 TRAINING OBJECTIVES

.1 Training to be detailed, with duration to ensure:

.1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.

.2 Effective on-going inspection, measurements of system performance.

.3 Proper preventive maintenance, diagnosis and trouble-shooting.

.4 Ability to update documentation.

.5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING MATERIALS

.1 Instructors to be responsible for content and quality.

.2 Training materials to include:

.1 "As-Built" Contract Documents.

.2 Operating Manual.

.3 Maintenance Manual.

.4 Management Manual.

.5 TAB and PV Reports.

.3 Project Manager, Commissioning Manager and Facility Manager will review training manuals.

.4 Training materials to be in a format that permits future training procedures to same degree of detail.

.5 Supplement training materials:

.1 Transparencies for overhead projectors and/or PowerPoint slides.

.2 Multimedia presentations.

.3 Manufacturer's training videos.

.4 Equipment models.

1.6 SCHEDULING

.1 Include in Commissioning Schedule time for training.

.2 Deliver training during regular working hours, training sessions to be 3 hours in length.

.3 Training to be completed prior to acceptance of facility. Allow for

.1 interim training at temporary ATB

.2 training for each phase

.3 follow-up training session and system demonstration 90 days after new ATB occupancy.

1.7 RESPONSIBILITIES

.1 Be responsible for:

.1 Implementation of training activities,

.2 Coordination among instructors,

.3 Quality of training, training materials,

.2 Departmental Representative will evaluate training and materials.

.3 Upon completion of training, provide written report, signed by Instructors and attendees, and witnessed by by Cx Authority and Departmental Representative.

1.8 MECHANICAL SYSTEM TRAINING

.1 Organize and conduct training courses to instruct the Departmental Representative in the operation and preventative maintenance of equipment and systems provided at the completion of the project.

.2 Provide services of qualified personnel, including each sub-trade, each major equipment supplier and design engineer to and instruct on their equipment or systems.

.3 One-person day shall be eight hours including one half hour for breaks, and one person week shall be five person days.

.4 Submit sessions schedule and list of representatives to the Departmental Representative for approval 30 days prior to course starting date. Confirm attendance of course by written notification to all participants, followed by verbal confirmation just prior to course starting date.

.5 Submit final copies of record drawings and operating and maintenance manuals to Departmental Representative.

.6 Submit a written follow-up of all courses, complete with an attendants list to the Departmental Representative.

.7 Systems Course: Allow a minimum of 8 hours of instruction to conduct systems training courses addressing the following topics:

- .1 Air Systems:
  - .1 Review operation of systems and equipment:
    - .1 Air systems
    - .2 All exhaust systems
  - .2 Review equipment maintenance.
  - .3 Air system site tour (air handling units/ventilation/ fans)
    - .1 Demonstrate start/stop
    - .2 Components.
    - .3 Maintenance.
- .2 Cooling Systems:
  - .1 Review operation of system and equipment
  - .2 Review condensing unit and maintenance
  - .3 Review system maintenance.
  - .4 Cooling system site tour.
  - .5 Demonstrate start/stop.
    - .1 Auto control.
    - .2 Maintenance.
- .3 Heating System:
  - .1 Review operation of system and equipment.
  - .2 Review equipment maintenance.
  - .3 Heating system site tour.
- .4 Plumbing:
  - .1 Review system operation equipment.

.2 Review equipment maintenance including:

.1 Compressed Air

.2 Fixtures

.5 Site Services:

.1 Sanitary/storm/domestic water.

.8 Controls Course: Allow a minimum of 8 hours of instruction and an additional 8 hours of instructions to conduct the controls systems training courses as follows:

.1 Provide the services of competent instructors who will give instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements of the equipment and system specified. The training shall be specifically for the system installed rather than being a general "canned" training course. The Departmental Representative shall have the right to approve/reject the instructors based on their qualifications. All equipment and material required for classroom training shall be provided by the General Contractor.

.2 Training Program: provide in two phases over a 6 month period, the time interval specified for each phase.

.1 First phase: this phase shall be for a period of 1 day prior to the 30 day test period. Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation. First phase training shall include the following:

.1 General EMCS Architectural (overview).

.2 System Communications (overview).

.3 Operation of computer and peripherals (overview).

.4 Operator Interface functions for control of HV AC systems (detailed).

.5 Control Logic (detailed for each system).

.6 Report Generation (overview).

.7 Colour graphics generation.

.8 Elementary preventive maintenance (detailed).

.2 Second Phase: this phase of training shall be conducted eight weeks after system acceptance for a period of one day. Training will be provided for three categories of personnel: operators, equipment maintenance personnel. The training shall include as a minimum, but not be limited to:

.1 Operator Training and Equipment Maintainer’s Training include:

.1 General equipment layout.

.2 Troubleshooting of all EMCS components.

.3 Preventive maintenance of all EMCS components.

.4 Sensors and controls maintenance and calibration

1.9 ELECTRICAL SYSTEM TRAINING

.1 Organize and conduct training courses to instruct the Departmental Representative in the operation and preventative maintenance of equipment and systems provided at the completion of the project.

.2 Provide services of qualified personnel, including each sub-trade, each major equipment supplier and design engineer to and instruct on their equipment or systems.

.3 One-person day shall be eight hours including one half hour for breaks, and one person week shall be five person days.

.4 Submit sessions schedule and list of representatives to the Departmental Representative for approval 30 days prior to course starting date. Confirm attendance of course by written notification to all participants, followed by verbal confirmation just prior to course starting date.

.5 Submit final copies of record drawings and operating and maintenance manuals to Departmental Representative. Submit a written follow-up of all courses, complete with an attendants list to the Departmental Representative.

.6 Systems Course: Allow a minimum of 64hours of instruction (Eight 8-hour training sessions) to conduct systems training courses addressing but not limited to the following topics:

.1 Low Voltage Distribution Systems.

.1 Review: Switchboards, breakers, transformers, grounding and bonding.

.2 Lighting and Lighting Systems.

.1 Review: Lighting equipment installations, lighting controls and emergency lighting systems.

.3 Fire Alarm and Emergency Alarm Systems:

.1 Review and demonstrate the operation, and maintenance of the alarms systems.

.4 Communications Systems:

.1 Review communications infrastructure and inside/outside plant distribution.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures and 01 74 21 - Construction/Demolition Waste Management Disposal.

.1 Construction Waste Management:

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

.2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.

1.2 SITE CONDITIONS

.2 If material resembling spray or trowel-applied asbestos or other designated substance listed as hazardous be encountered, stop work, take preventative measures, and notify Departmental Representative immediately.

.1 Proceed only after receipt of written instructions have been received from Departmental Representative.

.3 Notify Departmental Representative before disrupting building access or services.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 EXAMINATION

.1 Inspect building and site with Departmental Representative and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.

3.2 PREPARATION

.1 Protection of In-Place Conditions:

.1 Prevent movement, settlement, or damage to adjacent structures, landscaping features, and parts of building to remain in place.

.2 Keep noise, dust, and inconvenience to occupants to minimum.

.3 Protect building systems, services and equipment.

.4 Provide temporary dust screens, covers, railings, supports and other protection as required.

.5 Do Work in accordance with Section 01 35 29.06 - Health and Safety Requirements.

3.3 DEMOLITION/REMOVAL:

.1 Remove items as indicated.

.2 Remove parts of existing building to permit new construction.

.3 Trim edges of partially demolished building elements to tolerances as defined by Departmental Representative to suit future use and new construction.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Refer to demolition drawings and specifications for items to be salvaged for reuse.

.4 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 Description

.1 Provide all material, labor, equipment, design and services necessary for the installation and replacement/upgrade necessary for the existing Greenhouse systems, as listed herein and as noted on the drawings.

.2 Contractor will be responsible for the design, upgrade and replacement of the automated controls system and equipment listed herein.

.3 All replacement and upgrade work is to at minimum, meet the existing operational and performance criteria of existing equipment.

1.2 Work Included

.1 Upgrade existing automated Greenhouse control system and sensors.

.2 Provide all necessary wiring, connections, hardware, and interface for a new remote terminal to be located in the main building, location as specified by the Departmental Representative.

.3 Upgrade and replace existing ridge and side wall vent motors, shafts, bearings, racks and pinions and connect to the upgraded control system.

.4 Connect vent motor potentiometers to new control system.

.5 Upgrade and replace existing overhead shade and blackout screen system, including motors, guide wires, and fabrics and connect to the upgraded control system.

.6 Lock and exit hardware to existing doors.

.7 Co-ordinate the work according to the proposed phases as described in the Architectural drawings.

1.3 Related Work

.1 Electrical

.1 Power, wiring, and connections to replaced or upgraded components.

.2 Mechanical

.1 Heating system.

1.4 Submittals

.1 Submit shop drawings and samples in accordance with Section 01 33 00.

.2 Shop drawings to include manufacturers' product specifications, test results showing compliance with performance criteria described below. Indicate pertinent dimensioning, general construction, component connections and locations, anchorage methods, locations and installation details.

.1 Design, operations, and specifications for Greenhouse Controls.

.2 All motors and related equipment data sheets.

.3 Provide samples of overhead shade fabric and blackout screen fabric.

1.5 Quality Assurance

.1 The Work contained herein shall be conducted by the contractor or their qualified Greenhouse specialty contractor with at least five (5) years' experience in Greenhouse systems and controls of similar type, size, and complexity.

1.6 Delivery

.1 Packaged materials to be delivered in accordance with the construction schedule in original, unopened, labelled containers of the approved manufacturers.

.2 Delivered materials which are damaged or in any way do not comply with these specifications will be rejected by the Consultant and shall be removed from the job site and replaced with acceptable materials at no additional cost.

1.7 Storage

.1 Store materials on site as designated in the areas on site as approved by the Departmental Representative.

.2 Provide adequate protection to all materials whilst in storage. Do not remove materials or equipment from packaging until ready for installation.

.3 Replace any broken units regardless of cause at no extra cost to the Owner.

1.8 Performance Criteria

.1 The Contractor will be responsible for ensuring upgrades to motors or equipment will conform to the existing Live and Dead load capacities of the existing Greenhouse structure.

.2 The Contractor will be responsible for confirming existing dimensions, locations, associated components, and operational parameters of existing systems prior to performing any upgrades. Upgrades forming part of this contract are to equal or exceed the operational and performance capacity of the existing systems being replaced.

.3 The Contractor will upgrade/replace the existing components and systems as specified with new and modern day components that equal or exceed the existing performance specifications for that component or piece of equipment. Where the performance criteria of a proposed component or equipment is in question, the Departmental Representative will provide the final approval of its use.

.4 The performance criteria of each component shall conform to that listed under Part 2.0 – Components.

Part 2 Products

2.1 Components

.1 Ridge and Side Wall Vents

.1 Description

.1 Replace existing ridge and side wall vent gear motors with new.

.2 Replace existing vent position indicators with new and connect to upgraded Greenhouse control software system.

.3 Replace existing vent racks and pinions, drives, shaft, and shaft bearings with new.

.4 Calibrate entire system with upgraded Greenhouse control software system to fully open, fully close, and intermediate positions as required by the user.

.2 Existing Equipment

.1 Existing vent motors are type: Dansk Gartneri-Teknik LG10 Gear motor.

.3 Performance Requirements

.1 New gear motors shall:

.1 At minimum meet the performance requirements of the existing DGT LG10 gear motor performance specifications and the performance requirements listed herein or approved equal.

.2 Be CSA approved.

.3 Be rated to exact voltages as indicated on Electrical Drawings (220V and 240V are not acceptable).

.4 Include at least 2 limit switches in each direction (limit switches and/or torque limits), except vent motors shall have, in addition, a time protection delay on opening.

.1 Safety features on opening vent to include limit switch and torque switch.

.2 Safety features on closing vent to include time delay protection, limit switch and torque switch.

.3 Be provided with overload protection.

.4 Be provided with built-in internal potentiometer compatible and be connected to the Greenhouse controls.

.2 Blackout Shade System

.1 Description

.1 Replace the existing automated blackout shade system including fabrics, guide wires, and motors with new.

.2 The blackout shade system exists in Compartments G01, G02, and G03 and comprises vertical and overhead curtains.

.2 Existing Equipment

.1 Existing shade motors are type: Dansk Gartneri-Teknik KTH30 Gear motor.

.2 Existing fabric consists of one layer of black fabric and one layer of silver fabric bonded together with woven fabric to provide 100% shading value and is flame and UV resistant.

.3 Performance Requirements

.1 New gear motors shall:

.1 At minimum meet the performance requirements of the existing KTH30 gear motor performance specifications, and the performance requirements listed herein or approved equal.

.2 Be CSA approved.

.3 Be rated to exact voltages as indicated on Electrical Drawings (220V and 240V are not acceptable).

.4 Include at least 2 limit switches in each direction (limit switches and/or torque limits), except vent motors shall have, in addition, a time protection delay on opening.

.1 Safety features on opening vent to include limit switch and torque switch.

.2 Safety features on closing vent to include time delay protection, limit switch and torque switch.

.5 Be provided with overload protection.

.6 Be provided with built-in internal potentiometer compatible and be connected to the Greenhouse controls.

.7 Be of appropriate capacity for the function required.

.2 New blackout fabric and guide wires shall:

.1 Be gutter to gutter system as indicated on the drawings.

.2 Be of fabric that is:

.1 One layer of black fabric and one layer of silver fabric bonded together with woven fabric, fashioned with appropriate perimeter seals to provide 100% shading value.

.2 Be flame and UV resistant.

.3 Leading edge of fabric shall be fastened to 19mm diameter aluminum tube with quick disconnect device.

.4 Fabric will be connected with cables to guide wires activated by gear motors.

.5 Have top and side covers are to be sewn in three separate sections, corresponding to the compartment dimensions respective to G01, G02, and G03. Each section shall be able to be lapped to an adjacent section and be fastened with Velcro type fasteners.

.6 Be configured such that any one of the compartments G01, G02, or G03 can be contained by the blackout shade system.

.7 Be made to have 100% light-tight seal between wall and ceiling curtains.

.8 Contain openings with light-tight closures to allow access into the compartments from the corridor during blackout conditions. Coordinate locations with existing compartment door locations.

.9 Have wall curtains at exterior walls be sloped to clear wall vent operators and held with nylon guide wires for minimum interference with other services.

.10 Horizontal overhead curtains to be suspended by loops from stainless steel wires.

.11 Have a positive drainage system for removal of condensed and/or leakage water. Ensure this system does not reduce the blackout efficiency of the system.

.12 Compress the overhead curtains when open to cause minimum bulk and minimum shading.

.3 Automatic Overhead Shading System

.1 Description

.1 Replace the existing automatic overhead shade system including fabrics, guide wires, and motors with new.

.2 The automatic overhead shade system exists in all compartments.

.2 Existing Equipment

.1 Existing shade motors are type: Dansk Gartneri-Teknik KTH30 Gear motor.

.2 Existing overhead shade fabric is 100% polyester fabric with 25% shade value and is flame, mildew, and UV resistant.

.3 Performance Requirements

.1 New gear motors shall:

.1 At minimum meet the performance requirements of the existing KTH30 gear motor performance specifications.

.2 Be CSA approved.

.3 Be rated to exact voltages as indicated on Electrical Drawings (220V and 240V are not acceptable).

.4 Include at least 2 limit switches in each direction (limit switches and/or torque limits), except vent motors shall have, in addition, a time protection delay on opening.

.1 Safety features on opening vent to include limit switch and torque switch.

.2 Safety features on closing vent to include time delay

protection, limit switch and torque switch.

.5 Be provided with overload protection.

.6 Be provided with built-in internal potentiometer compatible and be connected to the Greenhouse controls.

.7 Be of appropriate capacity for the function required.

.2 New automatic shade fabric and guide wires shall:

.1 Be gutter to gutter system as indicated on the drawings.

.2 Be of fabric that is:

.1 Flame, mildew, and UV resistant with 25% shade value.

.3 Leading edge of fabric shall be fastened to 19mm diameter aluminum tube with quick disconnect device.

.4 Fabric will be connected with cables to guide wires activated by gear motors.

.5 Be designed to compress fabric when in the open position for minimum shading.

.4 Exit Door Hardware

.1 Description

.1 Retrofit existing pair of exterior doors with new exit hardware and locks to the double doors at the south end of the Greenhouse.

.2 The north doors interfacing with the Header House are to remain as is.

.2 Existing Equipment

.1 Existing exterior doors are clear anodized “storefront” type, fully glazed doors constructed of 44.5mm aluminum tubular sections, 48.4mm stiles, 57.4mm headrail and midrail, and 99.2mm bottom rail. 2mm aluminum panels adhered to plywood core form the bottom panel.

.3 Performance Requirements

.1 Exit device to be surface vertical rod type – Panic and Fire Exit Hardware rated to conform to UL10C and UBC 7-2.

.2 Finish to match exterior.

.3 Provide all strikes, touchbar device, cylinders, locks, rods, trims and handles.

.4 Acceptable product or approved equal:

.1 Stanley APEX 2000 Series

FL2203 x 1700C x RHRB x 628 x 3’6” x 7’-0” x 1-3/4”

.5 Greenhouse Controls

.1 Description

.1 Upgrade the existing Greenhouse control software system, operating terminal, and associated hardware as required to the most current version

at time of construction.

.2 Replace existing zone sensors and other sensors including:

.1 Temperature sensors

.2 Vent position sensors

.3 Weather station sensors with RH measurements

.3 Connect the upgraded software controls system to all newly replaced motors, sensors, potentiometers, as well as to existing systems. Ensure compatibility of entire system.

.4 Determine all Greenhouse control system parameters, set-points, and settings in consultation with the Departmental Representative.

.5 Integrate existing boiler controls into Greenhouse control system. The Greenhouse control system shall be able to control the existing boilers to manage set points as required by the user/control system.

.6 Upgrade the existing control terminal and provide a new second remote terminal located within the main building.

.7 The Contractor shall be responsible for the design of the controls system and its components to ensure fully functioning operability, at minimum meeting the performance requirements stated herein.

.8 Should it be more economical to replace the existing control system with an entirely new system, the Contractor will be allowed to do so as long as he can demonstrate the new system meets or exceeds the performance of the existing system and can provide all the required functional performance requirements stated herein. Approval from the Departmental Representative will be required prior to proceeding.

.9 Refer to Appendix B – Sequence of Operation of Controls. The performance and functional criteria stated therein shall form the basis of design for the upgraded system.

.2 Existing Equipment

.1 The existing Greenhouse controls system is a Priva Integro system last upgraded in 2008. The 2008 version of this software system is no longer supported.

.2 The existing software version is Priva Integro version 725 and Priva Office 4.

.3 Existing zone sensors are wet bulb type technology.

.4 Existing temperature, vent position, and weather station sensors were originally installed in the 1990’s, exceeding 30 years life span and are now obsolete.

.3 Performance Requirements

.1 The Greenhouse control system should be designed in accordance with the latest advancements in greenhouse control, with the capabilities of regulating the environmental factors pertaining to plant growth, and the collecting and processing of data.

.2 At minimum, the control system upgrade will be to the latest, most up-to-date software version provided by the supplier.

.3 Provide any upgrades to the hardware as required and necessary to perform the software upgrade.

.4 All functions are to be accessible through the existing remote terminal.

.5 New sensors are to be of the latest technology type and shall be able to at minimum, log readings achieved by current existing sensors.

.6 The Greenhouse control system is to be tied into all the sensors and component systems and be able to automatically modulate environmental conditions according to set parameters, with the variables including:

.1 Heating

.2 Ventilation

.3 Temperature

.4 Humidity

.5 Lighting

.4 Be able to calculate all control parameters in consideration and determine the appropriate operating conditions and sequence different mechanical systems to best maintain desired set points.

.5 Provide new hardware and new software component warranties for a minimum of two (2) year period from date of final acceptance of work.

.6 Certify and warrant the new system is Y2K compliant.

.7 Provide local manufacturer/supplier toll-free telephone and/or on-site technical support for the system, including applications support within 24hrs.

Part 3 Execution

3.1 All equipment, components, and installation is to be in accordance with manufacturer's installation instructions and to be by recognized industry practices to insure intended function.

3.2 Where possible, re-use existing wiring, cabling, and feeds.

3.3 Where existing wiring, cabling, or components are aged and no longer of good use for new components, replace with new.

3.4 All work related to Greenhouse controls, systems, and components shall be installed by qualified Greenhouse Contractor.

3.5 All mechanical, electrical, and plumbing work will be performed by qualified electrical, mechanical, and plumbing contractor.

3.6 The Controls contractor will be responsible for equipment startup, control wiring, and calibration, as well as testing and commissioning of the controls system in accordance with the prescribed phases of the project and section 01 32 16 – Construction Progress Schedule.

END OF SECTION

1. General

1.1 RELATED SECTIONS

.1 Division 1, Division 23

.2 This section of the specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.3 Specifications are not intended to delegate functions or to delegate work and supply to any specific trade. The work shall include all labour, materials, equipment and tools required for a complete and working installation as described but not necessarily limited to items in the Specifications and shown on the drawings.

.4 The successful bidder covenants and agrees to indemnify and save harmless the Owner against all claims, demands or actions of every kind whatsoever made against the Owner as a result of anything done in connection with the work undertaken by the successful bidder and his sub-trades.

1.2 CODES, REGULATIONS AND BY-LAWS

.1 The Contractor shall make himself fully acquainted with all codes and by-laws as relating to his installation and equipment. Such regulations shall have precedence over the drawings and specifications and the Contractor shall be required, without extra compensation, to carry out any conditions embodied in such codes and by-laws. The Contractor must obtain and pay for all permits for the execution of his work and pay all charges incidental to such permits. This shall include all permits and fees that must be made in the Owner's name and which are necessary in order that the Contractor may complete the work of the Contract.

.2 All changes and alterations required by authorized inspectors of any authority having jurisdiction shall be carried out without charge or expense to the Owner.

.3 Before starting any work, submit the required number of copies of drawings and specifications to the authorities for their approval and comments. Pay all required fees and comply with any changes requested, but notify the Consultant immediately of such changes.

.4 Include for all local, provincial and federal taxes that are in effect at the time of bidding. The most recent codes and by-laws shall be followed. These shall supersede all codes listed in the specification.

1.3 DEFINITIONS

.1 In the Contract Documents, the following definitions apply:

.1 Owner: Means Public Works and Government Services Canada

.2 Architect: Means IBI Group

.3 Consultant: Means MCW Consultants Ltd.

.4 General Contractor / Construction Manager: Means the company carrying out the general contract work.

.5 Mechanical Contractor: Means the Trade Contractor ('Contractor') whose bid is accepted by the Owner.

.6 Work: Means the whole of the works, materials, matters and things that are required to be done, furnished and performed by the Trade Contractors under the Contract Documents.

.2 Definitions used in this Division will have the following meaning:

.1 "Concealed": Pipes, ducts in trenches, chases, furred spaces, pipe shafts, or hung ceilings.

.2 "Exposed": Regarding insulation and painting of piping, ducts will mean that they are not "concealed" as defined herein.

.3 "Piping": Includes in addition to pipe, all fittings, valves, hangers and other accessories which comprise a system.

.3 Notwithstanding any definition elsewhere in the contract documents, wherever the term "Provide" is used in relationship to equipment, ductwork, piping, in this Division, it means "Supply, Install and Connect". Whenever the term "supply" is used, it means supply only.

1.4 STANDARD OF MATERIALS AND WORKMANSHIP

.1 All materials furnished under the Contract and entering into this installation shall be new, and be furnished, delivered, erected, connected and finished in every detail. All equipment and material shall be supplied with the approval of the Consultant, and installed in strict accordance with recommendations of the manufacturer. Equipment shall have CSA, ULC, c-UL or Warnock Hersey approval label as applicable. The Contractor shall be responsible to confirm that all materials used are suitable for the use intended and meet WCB requirements.

.2 Where a manufacturer's name is mentioned, it is for the purpose of setting a standard of quality, performance, capacity, appearance and serviceability. Acceptance and approval by Departmental Representative is required prior to use of named products, their equivalent, or better.

.3 The Contractor and manufacturer's agent must assume full responsibility for ensuring that all noise levels, space, weight, connections, access, performance power and wiring requirements, are considered and costs, therefore, included in the bid. Equipment requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.

1.5 SUBMITTALS

.1 Submittals: in accordance with Division 1 Requirements.

.2 Shop drawings to show:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Certification of compliance to applicable codes.

.4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

.5 Closeout Submittals:

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

.2 Operation and maintenance manual approved by, and final copies deposited with Consultant before final inspection.

.3 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Valves schedule and flow diagram.

.6 Colour coding chart.

.4 Maintenance data to include:

.1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.

.5 Performance data to include:

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

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 20 00 50 - Testing, Adjusting and Balancing.

.6 Approvals:

.1 Submit copies of draft Operation and Maintenance Manual to Consultant for approval.

.2 Make changes as required and re-submit as directed by Consultant.

.7 Additional data:

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

.8 Site records:

.1 Consultant will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.9 As-built drawings:

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

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

.3 Submit to Consultant for approval and make corrections as directed.

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

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

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

2. Products

2.1 MATERIALS

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

.2 Do verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

3. Execution

3.1 CLEANING

.1 Contractor shall cap duct during construction and maintain duct cleanliness. Any duct cleaning required will be done by the contractor at no additional cost.

3.2 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.

.2 Manufacturer's Field Services:

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

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

3.3 DEMONSTRATION

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

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

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

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

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

3.4 PROTECTION

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

END OF SECTION

1. General

1.1 RELATED REQUIREMENTS

.1 Division 01 – General Requirements

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

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

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, paddling and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2. Execution

2.1 APPLICATION

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

2.2 CONNECTIONS TO EQUIPMENT

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

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

.3 Use double swing joints or flexible pipe connectors when equipment mounted on vibration isolation and when piping subject to movement.

2.3 CLEARANCES

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

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

2.4 DRAINS

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

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

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

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

2.5 AIR VENTS

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

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

2.6 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.

2.7 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.

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

.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 and as indicated.

.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 Provide for thermal expansion as indicated.

.14 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless otherwise indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

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

.6 Install butterfly valves on chilled water and related condenser water systems only.

.7 Install butterfly valves between weld neck flanges to ensure full compression of liner.

.8 Install plug cocks or ball valves for glycol service.

.9 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

.15 Check Valves:

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

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

2.8 SLEEVES

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

.2 Material: schedule 40 black steel pipe.

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

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere: Provide space for firestopping. 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.

2.9 ESCUTCHEONS

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

.2 Construction: one piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

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

2.10 FLUSHING OUT OF PIPING SYSTEMS

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

.2 Before start-up, clean interior of piping systems in accordance with requirements of Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems.

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

2.11 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.

.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 Commissioning Agent.

.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.

2.12 CLEANING

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

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal

.3 Section 23 05 53.01 - Mechanical Identification

1.3 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.

1.4 SUBMITTALS

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

.2 Submit shop drawings and product data.

.3 Submit manufacturer's product data for following items:

.1 Thermometers.

.2 Pressure gauges.

1.5 HEALTH AND SAFETY

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

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Collect, separate and place in designated containers materials for reuse and recycling, in accordance with Waste Management Plan.

.3 Fold up metal banding, flatten and place in designated area for recycling.

.4 Place materials defined as hazardous or toxic waste in designated containers.

.5 Ensure emptied containers are sealed, labelled and stored safely for disposal away from children.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid point of scale or range.

.2 Ranges: as indicated.

2.2 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel or phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Siphon for steam service, with needle valve.
.2 Snubber for pulsating operation.
.3 Diaphragm assembly for corrosive service.
.4 Gasketted pressure relief back with solid front.
.5 Bronze stop cock.
.6 Oil filled for high vibration applications.

Part 3 Execution

3.1 GENERAL

.1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 PRESSURE GAUGES

.1 Install in following locations:

.1 Suction and discharge of pumps.
.2 Upstream and downstream of PRV's.
.3 Upstream and downstream of control valves.
.4 Inlet and outlet of coils.
.5 Inlet and outlet of liquid side of heat exchangers.

.6 Outlet of boilers.

.7 In other locations as indicated.

.2 Install gauge cocks for balancing purposes, elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation.

3.3 NAMEPLATES

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

END OF SECTION

1. General

1.1 SUMMARY

.1 Section Includes:

.1 Bronze - valves.

.2 Related Sections:

.1 Section 01 30 00 - Administrative Requirements.
.2 Section 01 40 00 - Quality Requirements.
.3 Section 01 60 00 - Product Requirements.
.4 Section 01 70 00 - Execution and Closeout Requirement.
.5 Section 01 74 19 - Waste Management and Disposal.
.6 Section 23 05 00- Common Work Results – HVAC

1.2 REFERENCES

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

.1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
.2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.

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

.1 ASTM A276-04, Specification for Stainless Steel Bars and Shapes.
.2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
.3 ASTM B283-99a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
.4 ASTM B505/B505M-02, Specification for Copper-Base Alloy Continuous Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

.1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
.2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.
.3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit data for valves specified in this section.

.3 Closeout Submittals:

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

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 DISPOSAL

.1 Waste Management and Disposal:

.2 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.6 MAINTENANCE

.1 Extra Materials:

.2 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.
.2 Discs: one for every 10 valves, each size. Minimum 1.
.3 Stem packing: one for every 10 valves, each size. Minimum 1.
.4 Valve handles: 2 of each size.
.5 Gaskets for flanges: one for every 10 flanged joints.

2. Products

2.1 MATERIALS

.1 Valves:

.1 Except for specialty valves, to be single manufacturer.
.2 All products to have CRN registration numbers.

.2 End Connections:

.1 Connection into adjacent piping/tubing:
.1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
.2 Copper tube systems: Solder ends to ANSI/ASME B16.18.
.3 Grooved ends similar to CSA B242. (Copper-tube dimensioned.)

.3 Lockshield Keys:

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

.4 Gate Valves:

.1 Requirements common to gate valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Bonnet: union with hexagonal shoulders.

.3 Connections: screwed with hexagonal shoulders.

.4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.

.5 Packing: non-asbestos.

.6 Handwheel: non-ferrous.

.7 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125

.1 Body: with long disc guides, screwed bonnet with stem retaining nut.

.2 Operator: Handwheel.

.3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:

.1 Body: with long disc guides, screwed bonnet with stem retaining nut.

.2 Operator: Handwheel.

.4 NPS 2 and under, rising stem, split wedge disc, Class 125:

.1 Body: with long disc guides, screwed bonnet.

.2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.

.3 Operator: Handwheel.

.5 NPS 2 and under, rising stem, solid wedge disc, Class 125:

.1 Body: with long disc guides, screwed bonnet.

.2 Operator: Handwheel.

.6 NPS 2 and under, rising stem, solid wedge disc, Class 150:

.1 Body: with long disc guides, screwed or union bonnet.

.2 Operator: Handwheel.

.5 Globe Valves:

.1 Requirements common to globe valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Bonnet: union with hexagonal shoulders.

.3 Connections: screwed with hexagonal shoulders.

.4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.

.5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.

.6 Handwheel: non-ferrous.

.7 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, composition disc, Class 125:

.1 Body and bonnet: screwed bonnet.

.2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: Handwheel.

.3 NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: Handwheel.

.4 NPS 2 and under, plug disc, Class 150, screwed ends:

.1 Body and bonnet: union bonnet.

.2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.

.3 Operator: Handwheel.

.5 Angle valve, NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.

.3 Operator: Handwheel.

.6 Check Valves:

.1 Requirements common to check valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Connections: screwed with hexagonal shoulders.

.2 NPS 2 and under, swing type, bronze disc, Class 125:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.3 NPS 2 and under, swing type, bronze disc:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.4 NPS 2 and under, swing type, composition disc, Class 200:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.

.5 NPS 2 and under, horizontal lift type, composition disc, Class 150:

.1 Body: with integral seat, union bonnet ring with hex shoulders, cap.

.2 Disc: renewable PTFE no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.

.6 NPS 2 and under, vertical lift type, bronze disc, Class 125:

.1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

.7 Silent Check Valves:

.1 NPS 2 and under:

.1 Body: cast high tensile bronze to ASTM B62 with integral seat.

.2 Pressure rating: Class 125.

.3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.

.4 Disc and seat: renewable rotating disc.

.5 Stainless steel spring, heavy duty.

.6 Seat: regrindable.

.8 Ball Valves:

.1 NPS 2 and under:

.1 Body and cap: cast high tensile bronze to ASTM B62.

.2 Pressure rating: Class125, 860 kPa steam.

.3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders.

.4 Stem: tamperproof ball drive.

.5 Stem packing nut: external to body.

.6 Ball and seat: replaceable stainless steel or hard chrome solid ball and teflon seats.

.7 Stem seal: TFE with external packing nut.

.8 Operator: removable lever handle.

.9 Butterfly Valves:

.1 65 mm through 150 mm

.1 Copper tube dimensioned grooved ends.

.2 Cast bronze body.

.3 EPDM encapsulated ductile iron disc with integrally cast stem.

.4 Basis of Design: Victaulic Style 608

.10 Balancing Valves:

.1 Up to 50 mm

.1 Return side of heating/cooling elements.

.2 Read out ports, drain valve and cap.

.3 Position readout and memory.

.4 Polyurethane packaging (R4-5) to be used as removable insulation.

.5 Coil-Hook-up Connections: Victaulic Koil-Kits Series 799 or 79V may be used at coil connections. The kit shall include a Series 786/787/78K

circuit balancing valve, Series 78Y Strainer-Ball, Series 78U Union-Port fitting, with Series 78T ball valve and required coil hoses. A Style 793 and/or 794 differential pressure controller shall be provided as required. A meter shall be provided by the valve manufacturer that shall remain with the building owner after commissioning.

.6 Basis of Design: Victaulic / TA Hydronics.

3. Execution

3.1 INSTALLATION

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

.2 Remove internal parts before soldering.

.3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

.4 Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings. (The couplings shall serve as disconnect points.)

3.2 VERIFICATION

.1 Contractor's Verification, include:

- .1 Materials and resources.
- .2 Storage and collection of recyclables.
- .3 Construction waste management.
- .4 Resource reuse.
- .5 Local/regional materials.
- .6 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

1.2 REFERENCES

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

.1 ANSI/ASME B31.1-[04], Power Piping.

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

.1 ASTM A125-[1996(R2001)], Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-[04], Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-[04a], Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

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

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

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

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

.6 Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

.1 Design Requirements:

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

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

.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, etc. to withstand seismic events as specified Section 230549.01 – Seismic Restraint System (SRS) – Type P2 Buildings.

1.4 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings: submit drawings stamped and signed by registered professional engineer.

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

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

.5 Closeout Submittals:

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

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.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 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 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.

2.2 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized, painted with zinc-rich paint after manufacture.

.2 Use electro-plating galvanizing process.

.3 Ensure steel hangers in contact with copper piping are copper plated.

.2 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel black galvanized

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

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

2.3 RISER CLAMPS

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

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

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated hot piping:

.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.5 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10] % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with:

.1 manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

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

.3 Clamps on riser piping:

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

.2 Bolt-tightening torques to industry standards.

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

.4 Cast iron pipes: install below joint.

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

.5 Use approved constant support type hangers where:

.1 vertical movement of pipework is 13 mm or more,

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

.6 Use variable support spring hangers where:

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

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

3.3 HANGER SPACING

.1 Fire protection: to applicable fire code.

.2 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

.3 Copper piping: up to NPS 1/2: every 1.5 m.

.4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

.5 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

.6 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

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

.2 Adjust hangers to equalize load.

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

3.5 HORIZONTAL MOVEMENT

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

.2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

.1 Ensure that rod is vertical under operating conditions.

.2 Equalize loads.

.2 Adjustable clevis:

.1 Tighten hanger load nut securely to ensure proper hanger performance.

.2 Tighten upper nut after adjustment.

.3 C-clamps:

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-[2002], Standard for the Installation of Sprinkler Systems.

.3 National Building Code of Canada (NBC) - [1995]

1.3 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.1 Shop drawings: submit drawings stamped and signed by registered professional engineer.

.2 Provide system shop drawings complete with performance and product data.

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

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

.3 Manufacturer's Field Reports: manufacturer's field reports specified.

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 Section 01 61 00 - Common Product Requirements.

.2 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 reuse and recycling in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

.1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 HANGERS

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

.2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with pre-compression washer and nut with deflection indicator.

.6 Performance: as indicated.

2.3 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

.1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.4 HORIZONTAL THRUST RESTRAINT

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

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

2.5 SEISMIC CONTROL MEASURES

.1 General:

.1 Following systems and/or equipment to remain operational during and after earthquakes

.2 Seismic control systems to work in every direction.

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

.4 Drilled or power driven anchors and fasteners not permitted.

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

.6 Supports of cast iron or threaded pipe not permitted.

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

.2 Static equipment:

.1 Anchor equipment to equipment supports. Anchor equipment supports to structure.

.2 Suspended equipment:

.1 Use one or more of following methods depending upon site conditions and or as indicated:

.1 Install tight to structure.

.2 Cross brace in every direction.

.3 Brace back to structure.

.4 Cable restraint system.

.3 Seismic restraints:

.1 Cushioning action gentle and steady.

.2 Never reach metal-like stiffness.

.3 Vibration isolated equipment:

.1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.

.2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.

.3 As indicated.

.4 Piping systems:

.1 Fire protection systems: to NFPA 13.

.2 Piping systems: hangers longer than 300 mm; brace at each hanger.

.3 Compatible with requirements for anchoring and guiding of piping systems.

.5 Bracing methods:

.1 Approved by Departmental Representative.

.2 Structural angles or channels.

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

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 Seismic control measures to meet requirements of NBC.

.2 Install vibration isolation equipment in accordance with manufacturer’s instructions and adjust mountings to level equipment.

.3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

.1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.

.2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.5 Where isolation is bolted to floor use vibration isolation rubber washers.

.6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

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

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

.1 After delivery and storage of Products.

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

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

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

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

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.2 Take vibration measurements for equipment as indicated.

.3 Provide Departmental Representative with notice 24 h in advance of commencement of tests.

.4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.5 Submit complete report of test results including sound curves.

3.4 CLEANING

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

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including laboratory fume hoods, BSC's, incinerators, kitchen equipment, electrical light fixtures, transformers, MCC's, UPS, diesel generators, standby power, fire protection, communications, equipment and systems, both vibration isolated and statically supported.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA G40.20/G40.21-[04], General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.3 National Building Code of Canada (NBC) - [1995]

1.3 DEFINITIONS

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

.2 SRS: acronym for Seismic Restraint System.

1.4 SYSTEM DESCRIPTION

.1 SRS fully integrated into, and compatible with:

.1 Noise and vibration controls specified elsewhere.

.2 Structural, mechanical, electrical design of project.

.2 Systems, equipment not required to be operational during and after seismic event.

.3 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.

.4 Designed by Professional Engineer specializing in design of SRS and registered in Province of British Columbia.

1.5 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings: submit drawings stamped and signed by registered professional engineer.

.3 Submit design data including:

.1 Full details of design criteria.

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

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

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

.5 Identification of location of devices.

.6 Schedules of types of SRS equipment and devices.

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

.8 Installation procedures and instructions.

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

.10 Work sheets, tables; simplified, conservative assumptions may be acceptable.

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

.4 Submit additional copy of shop drawings and product data to Structural Engineer for review of connection points to building structure.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

.6 Closeout Submittals:

.1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.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 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

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

2.2 SRS MANUFACTURER

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

2.3 GENERAL

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

.2 SRS to restrain seismic forces in every direction.

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

.4 SRS of Piping systems compatible with:

.1 Expansion, anchoring and guiding requirements.
.2 Equipment vibration isolation and equipment SRS.

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

.6 Attachments to RC structure:

.1 Use high strength mechanical expansion anchors.
.2 Drilled or power driven anchors not permitted.

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

2.4 SRS FOR STATIC EQUIPMENT, SYSTEMS

.1 Suspended equipment, systems:

.1 Use one or combination of following methods:
.1 Install tight to structure.
.2 Cross-brace in every direction.
.3 Brace back to structure.
.4 Slack cable restraint system.

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

.3 Hanger rods to withstand compressive loading and buckling.

2.5 SRS FOR VIBRATION ISOLATED EQUIPMENT

.1 Floor mounted equipment, systems:

.1 Use one or combination of following methods:

.1 Vibration isolators with built-in snubbers.

.2 Vibration isolators and separate snubbers.

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

.2 SRS to resist complete isolator unloading.

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

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

.2 Suspended equipment, systems:

.1 Use one or combination of following methods:

.1 Slack cable restraint system.

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

2.6 SLACK CABLE RESTRAINT SYSTEM (SCS)

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

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

.3 Hanger rods to withstand compressive loading and buckling.

Part 3 Execution

3.1 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 Attachment points and fasteners:

.1 To withstand same maximum load that seismic restraint is to resist and in every direction.

.2 Slack Cable Systems (SCS):

.1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.

.2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.

.3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.

.4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.

.5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.

.6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.

.7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.

.3 Install SRS at least 25 mm from equipment, systems, services.

.4 Co-ordinate connections with other disciplines.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

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

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

.1 After delivery and storage of Products.

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

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

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

.2 Inspection and Certification:

.1 SRS: inspected and certified by Manufacturer upon completion of installation.

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

3.4 CLEANING

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

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Sustainable requirements for construction and verification.

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.

.3 National Fire Protection Association (NFPA)

.1 NFPA 13-[2002], Standard for the Installation of Sprinkler Systems.

.2 NFPA 14-[2003], Standard for the Installation of Standpipe and Hose Systems.

1.3 SUBMITTALS

.1 Product Data:

.2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.3 Product data to include paint colour chips, other products specified in this section.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.2 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 Section 01 61 00 - Common Product Requirements.

.2 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 reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Dispose of unused paint coating material at official hazardous material collections site approved by Departmental Representative.

.3 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

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
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5

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

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

.4 Locations:

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

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

.5 Identification for PWGSC 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 Departmental Representative.

2.4 IDENTIFICATION OF PIPING SYSTEMS

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

.2 Pictograms:

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

.3 Legend:

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

.4 Arrows showing direction of flow:

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

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

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

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

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

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

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

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

.7 Colours and Legends:

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

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

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

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Raw water	Green	RAW WATER
River water	Green	RIVER WATER
Sea water	Green	SEA WATER
City water	Green	CITY WATER
Treated water	Green	TREATED WATER
Brine	Green	BRINE
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
High temp HW Htg. supply	Yellow	HTHW HTG. SUPPLY++
High temp HW Htg. return	Yellow	HTHW HTG. RETURN++
Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Steam [___]kPa	Yellow	WTR [___] kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Continuous blow-off	Yellow	CONT. BLOW-OFF
Chilled drinking water	Green	CH. DRINK WTR
Drinking water return	Green	CH. DRINK WTR. CIRC
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Contaminated lab waste	Yellow	CONT. LAB WASTE
Acid waste	Yellow	ACID WASTE (add source)
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
No. [___] fuel oil suction	Yellow	# [___] FUEL OIL
No. [___] fuel oil return	Yellow	# [___] FUEL OIL
Engine exhaust	Yellow	ENGINE EXHAUST
Lubricating oil	Yellow	LUB. OIL
Hydraulic oil	Yellow	HYDRAULIC OIL
Gasoline	Yellow	GASOLINE
Natural gas	to Codes	

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Propane	to Codes	
Gas regulator vents	to Codes	
Distilled water	Green	DISTILL. WTR
Demineralized water	Green	DEMIN. WATER
Chlorine	Yellow	CHLORINE
Nitrogen	Yellow	NITROGEN
Oxygen	Yellow	OXYGEN
Compressed air (<700kPa)	Green	COMP. AIR [___] kPa
Compressed air (>700kPa)	Yellow	COMP. AIR [___] kPa
Vacuum	Green	VACUUM
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS
Carbon dioxide	Red	CO2
Instrument air	Green	INSTRUMENT AIR

2.5 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.

2.6 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.

2.7 LANGUAGE

.1 Identification in English and French.

.2 Use one nameplate and label for each language both languages.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

.1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

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

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

.3 Identify systems, equipment to conform to PWGSC PMSS.

3.4 NAMEPLATES

.1 Locations:

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

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

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

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

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

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

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

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

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

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

3.6 VALVES, CONTROLLERS

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

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

.3 Number valves in each system consecutively.

3.7 CLEANING

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

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

END OF SECTION

1.0 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 Acceptable Testing, Adjusting and Balancing Contractors.

.3 The TAB Contractor (Testing, Adjusting and Balancing Agency) shall fully coordinate its work with the Construction Agent/Contractor, Controls Contractor Commissioning Agent and Mechanical Contractor, and shall provide the necessary correspondence to them related to the testing, adjusting and balancing work, with copies provided to the Consultant.

.4 The TAB Contractor shall schedule regular visit(s) to the site during construction to become fully acquainted with the installations and personnel involved with the project; site visits should correspond with site trade meetings. Provide written comments to the Mechanical Contractor with a copy to the Consultant of any items that require attention on related to the TAB contract.

.5 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.

.6 Refer to Section 23 08 00 Mechanical Systems Commissioning for additional requirement.

1.2 SCOPE

.1 The extent of systems and equipment requiring testing, adjusting and balancing work required by this Section are generally indicated on the drawings and on schedules.

.2 Testing, adjusting and balancing specified in this Section shall include, but not be limited to, the following systems:

- .1 Hydronic system including heating, glycol, chilled water and geothermal water systems.
- .2 Coordinate with Controls Contractor the setting of automatically controlled dampers, thermostats, valves and other devices.
- .3 Domestic hot water circulation.
- .4 Demonstrations and Instruction to Owner’s personnel regarding the balancing of systems.

1.3 QUALITY ASSURANCE

.1 Qualifications: A specialist with at least 5 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, who is not the installer of the system to be tested and is otherwise independent of the project.

.2 Codes and Standards: Provide testing, adjusting and balancing conforming CSA, ASME and to American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), SMACNA and AABC and the following:

.1 American National Standards Institute (ANSI): Comply with the following:

.1 S1.4 Specifications for Sound Level Meters

.2 S1.11 Specification For Octave-Band and Fractional-Octave-Band Analogue and Digital Filters

.2 American Society of Heating, Refrigerating, and Air Conditioning Engineers (AHSRAE) - HVAC Applications and ANSI / ASHRAE III, latest addition: Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing.

.3 SMACNA or AABC: Comply with the current editions of SMACNA'S "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or with AABC MN-1 "National Standards," as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.

.3 In addition hold back sums retained or withheld pursuant to the provisions of this Contract, a separate amount will be withheld from payments to the TAB Contractor until such time as the balancing work and deficiencies have been completed and the final report is accepted.

.4 Calibration of testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over one year.

.5 The TAB Contractor shall identify items related to the balancing work that are installed incorrectly, require correction, or have not been installed in accordance with contract drawings and specifications, pertaining to HVAC systems that would affect the balancing work. The TAB Contractor is required to provide written reports of all deficiencies and proposed recommendations to the Construction Manager, Commissioning Agent, Mechanical Contractor, and the Consultant.

.6 The General Contractor shall cooperate with the testing and balancing agency in the following manner:

.1 Provide sufficient time before final completion dates so that tests and balancing can be accomplished.

.2 The various system installers, suppliers and contractors shall provide all required materials, labour and tools to make corrections or revisions when required without undue delay. Install balancing dampers as required by testing and balancing agency.

.3 The Mechanical Contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of the same during each working day of testing and balancing.

.4 The TAB Contractor shall be kept informed of any major changes made to the system during construction, and shall be provided, for review, with a complete set of "Issued for Construction" drawings, including site instructions and mechanical change orders issued during construction.

.5 The General Contractor shall make space and facilities available to the Testing and Balancing Agency to enable their work to progress. The schedule of work of other trades shall be coordinated to avoid conflicts with the balancing work.

.6 The Mechanical Contractor shall adjust fan drives, change blade pitch angles, change sheaves and belts as directed by the Balancing Agency at no cost to the Owner.

.7 The Control Contractor shall make adjustments, in co-operation with the Balancing Agency, to control systems to facilitate the testing, adjusting and balancing process and setting of dampers linkages and valves operators and review damper and valve operation through full range of operation.

.8 The Mechanical Contractor shall employ a journeyman millwright to check the alignment of any V-belt drives and/or shaft couplings after they have been adjusted during the balancing process. Belt tension to be checked for proper adjustment.

.9 The Mechanical Contractor shall provide all instrument test ports and pipe wells required for balancing purposes.

1.4 SUBMITTALS

.1 Conform to the Submittals requirements of Division 1.

.2 Forms: Prior to start of work the TAB Contractor shall deliver to the Consultant a complete sample copy of standard forms (based on ASHRAE, SMACNA or AABC format) for testing and balancing work associated with the project. These forms shall serve as specific guidelines for producing final test report. Hybrid or non-standards forms are acceptable when approved by the Consultant. Data shall include, but not be limited to, a title page with building information, instrument lists, air flows, water flows, temperatures, sound levels, capacities, nameplate data and other information requested in this Section.

.3 Test Instruments: Prior to start of work, submit to the Consultant a list of all test instruments which will be used for the testing and balancing of all systems; include manufacturer's name and model No. for each instrument.

.4 Test Reports: Provide six (6) certified test reports, signed by the certified balancing technician who performed the work and by the balancing supervisor. The final reports shall be sealed and signed and include identification and types of instruments used, and their most recent calibration date. Provide two electronic diskettes, one to the Owner and one to the Consultant.

.5 Maintenance Data: Include, in maintenance manuals, copies of TAB certified test reports and identification of instruments.

.6 Qualifications: The Testing and Balancing Contractor shall submit the certified individual qualifications of all persons responsible for supervising and performing the actual work and the name of the certifying engineer or technologist with at least five years' experience in TAB work.

1.5 AGENDA

.1 The TAB Contractor's preliminary site review report(s) and agenda shall be submitted and approved prior to the start of testing and balancing work.

.1 A review of drawings, specifications and the documented changes during the construction. The TAB Contractor to carry out site visits to review the installation, and submit reports indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.

.2 The agenda shall include a general description of each air, glycol and water system with its associated equipment and operation cycles for heating and cooling.

.3 The agenda shall include a list of all air and water flow measurements to be performed at all mechanical equipment.

.4 The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas selected by the Consultant.

.5 The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts and sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.

.6 Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application and factors for:

.1 Air terminal configuration.

.2 Flow direction (supply or exhaust).

.3 Velocity corrections.

.4 Effective areas applicable to each size and type of air terminal.

.5 Density and altitude corrections.

.7 The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date.

.8 Provide mobile radios and smoke devices required for testing, balancing and commissioning of systems.

1.6 JOB CONDITIONS

.1 General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met:

.1 Work has been completed and is operable. Ensure that there is no latent residual work yet to be completed on the tested equipment.

.2 Work scheduled for testing, adjusting and balancing is to be clean and free from debris, dirt and discarded building materials.

.3 All architectural openings (doors, windows, and other openings), which may affect the operation of the system to be tested, adjusted, and balanced, are at their normal status.

.4 All related mechanical systems which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal operating conditions.

.5 Distribution System check for proper damper and valve clearances, free movement, seating, pinning to dampers and valves, spindle position of valves and damper blades in multi-leaf dampers. Alignment of control linkages, rigidity, lubrication and free movement.

2.0 Products

2.1 TEST HOLES

.1 Instrument test ports shall be provided in ducts, housings and pipes as necessary for the proper air and water measurements and to balance systems. At each location where ducts or plenums are insulated, test ports shall be provided with an approved extension with plug fitting.

2.2 PATCHING MATERIALS

.1 Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.

.1 Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

.2 Piping shall be capped with materials the same as the piping system.

.3 Insulation shall be neatly hemmed with metal or plastic edging, leaving test points visible for future testing.

2.3 TEST INSTRUMENTS

.1 Utilize instruments and equipment of type, precision, and capacity as recommended in the ASHRAE and/or SMNACA Standards and/or AABC manual.

.2 All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. A representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

.3 Permanently installed measuring instruments, such as temperature and pressure gauges, shall be checked against the calibrated standard instruments. Any device which does not meet specification requirements shall be replaced or recalibrated; coordinate with the Mechanical Contractor.

.4 The TAB Contractor may employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser/grille/register air flow measurements. The readout meters shall meet calibration requirements.

3.0 EXECUTION

3.1 PROCEDURES AND INSTRUMENTS, GENERAL

.1 All systems and components thereof shall be adjusted to perform as required by drawings and specifications. Consult with the Consultant regarding temperature drop/rise in the heating and/or cooling systems and for the general intent of the design prior to start of balancing.

.2 Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four hours duration after stabilized operating conditions have been established.

Capacities shall be based on temperatures and air and water quantities measured during such tests.

.3 Method of application of instrumentation shall be in accordance with the approved agenda.

.1 All instruments shall be applied in accordance with the manufacturer's certified instructions.

.2 All labour, instruments, and appliances required shall be furnished by the TAB Contractor.

.3 Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation. **Complete air balancing before commencing water balance where heating/cooling coils are installed in the air system.**

.4 Permanently marked final settings on valves, dampers and other adjustment devices. Set and lock all memory stop balancing devices.

.5 Seal all holes used for flow and pressure measurements.

.6 Check and co-ordinate field set controllers with the Control Contractor. Verify that room thermostats/sensors are controlling properly.

3.2 WATER SYSTEM PROCEDURES

.1 Preparation by the Mechanical and TAB Contractors:

.1 Mechanical Contractor to remove all strainers and clean same; reinstall.

.2 Mechanical Contractor to confirm that water has been treated and cleaned.

.3 Check pump rotation.

.4 Check expansion tank to determine they are not air bound and the system is completely full of water.

.5 Together with the Mechanical Contractor, check all air vents at high points of water systems and determine that all are installed and operating freely. Hydronic systems to be free of air.

.6 Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.

.7 Check operation of automatic bypass valve.

.8 Check and set operating temperatures of all equipment at design requirements.

.9 Complete the air balance before actual water balance begins.

.2 All HVAC, water and glycol systems shall be adjusted to provide required quantity to or through each component.

.3 Metering: Water quantities and pressures shall be measured with calibrated meters.

.1 Venture tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems. Systems shall be adjusted to provide the approved pressure drops through the heat transfer equipment and coils (except room units) prior to the capacity testing.

.2 Where flow metering fittings are not installed, in air/water type heat transfer equipment, flow balance shall be determined by measuring the air side energy differential across the heat transfer equipment. Measurement of water temperature differential shall be performed with the air system, adjusted as described herein, in operation.

.4 Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.

.5 Flow: Flow through bypass circuits at three-way valves shall be adjusted to equal that through the supply circuit, when the valve is in the bypass position.

.6 Distribution: Adjustment of distribution shall be effected by means of balancing devices (valves and fittings) and automatic flow control valves as provided; service valves shall not be used.

.1 Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating. Record all readings in the balancing report.

.7 Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

.8 Water System Test and Balance Procedure: Perform the following tests, and balance each system in accordance with the following requirements; test under varying conditions:

.1 Set all pumps to proper flow delivery.

.2 Adjust water flow though equipment, heat exchangers and coils.

.3 Test and record entering and leaving water temperatures through:

.1 Heat exchangers

.2 Heat pump units

.3 Boilers

.4 Chillers

.5 Coils

.4 Test and record water temperatures at inlet and outlet side of each terminal unit. Note rise or drop of temperatures from source.

.5 Proceed to balance each terminal unit.

.6 Upon completion of flow readings and adjustments at coils and equipment, mark all settings and record data.

.7 After adjustments to coils and equipment are made, recheck settings at the pumps as applicable and readjust if required.

.8 Record and check the following items at each coil.

.1 Inlet water temperatures.

.2 Leaving water temperatures.

.3 Water pressure drop of each coil.

.9 Pump operating suction and discharge pressures and final total dynamic head.

.10 List all mechanical specifications of pumps.

.11 Rated and running amperage of pump motor.

.12 Water metering device readings.

3.3 WATER SYSTEM DATA

.1 The certified report for reach water system shall include the data listed below:

.1 Pumps:

.1 Installation data

.1 Manufacturer and model

.2 Size (including suction and discharge pipe sizes)

.3 Type drive

.4 Motor HP, voltage, phase, and full load amps

.5 Bearing and seal data

.2 Design data:

.1 Flow

.2 Head

.3 Rpm, BHP, kW and amps

.3 Recorded data:

.1 Discharge pressures (full-flow and no-flow)

.2 Suction pressures (full-flow and no-flow) operating head

.3 Operating head

.4 Operating flow (from pump curves if metering is not provided) no-load

.5 Full-flow amps

.6 No-flow amps

3.4 CAPACITY VERIFICATION

.1 Air coil capacities shall be verified from air side measurement data. Capacities of coils shall be the difference of the energy carried by the air between the upstream and downstream coils.

.2 The measured air flow rate for the fan may be used for air coil capacity calculations providing no ducted bypassing of coil is occurring.

.3 Water / water heat exchanger equipment capacity shall be verified by measuring the flow rate and temperature differential of the water.

.4 Capacity verification shall be performed after air and water systems have been balanced.

.5 False load shall be applied if the upstream air or water does not meet the specified conditions at the time of test.

.6 After air and water flow are balanced, and with the temperature controls set to produce design cooling, measure and record all data necessary to compile a complete report to

demonstrate the acceptability of the various mechanical systems. Include the following data in the Balancing Report:

.1 Outside dry bulb and wet bulb temperature during tests.

.2 Inside dry bulb and wet bulb temperatures in six (6) selected areas of the conditioned space, room or area selected by the Consultant.

.3 Dry bulb temperature of air entering and leaving all coils.

.4 Temperature of water entering and leaving each water coil.

.5 Temperature at all thermometer well locations.

.6 Temperature of water entering and leaving each heat pump water chilling unit condenser and evaporator.

.7 Temperature of water entering and leaving each heat exchanger.

.8 Suction and discharge pressure and shut off head of each circulating water pump and domestic water pump.

.9 Certification: Certification shall include checking of adherence to TAB agenda, of calculations, of procedures, and evaluation of final summaries.

3.5 SOUND TEST PROCEDURES

.1 Tests of sound levels shall be made at each selection point included in the agenda,

.2 Sound level measurements shall be taken at times when the building is unoccupied, or when activity in surrounding areas and background noise level in areas tested are at a minimum and relatively free from sudden changes in noise levels.

.1 Measurements shall be taken with all equipment turned off, except that being tested.

.2 The required sound levels shall be measured at any point within a room not less than 6 feet from an air terminal or room unit, and not closer than 3 feet from any floor, wall, or ceiling surface.

.3 Sound levels shall be measured with a sound meter complying with ANSI S1.4. The “A” scale shall be used to measure over all sound levels for each of the eight octave bands.

.4 The certified report shall record data on sound levels, taken at each selected location, as follows:

.1 Certified report shall record all sound data, and their locations, after final adjustments of air and water systems involves:

.2 Source of sound and location.

.3 Diagram or description of relationship of sound source to measuring instrument.

.4 "A" scale readings equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).

.5 Readings at each specified octave band frequency equipment being tested turned off (ambient) equipment being tested turned on (operating conditions).

.6 "Equipment Components" of sound (noise) levels with applicable calculations per "Sound Test Procedures”.

.7 Graph showing relationship between pressure levels specified and recorded readings (use ASHRAE NC charts).

.5 Subsequent to any correctional construction work, such as acoustic corrections, measurement shall be made to verify that specified sound levels (NC) have been achieved).

3.6 CERTIFIED REPORTS

.1 Provide a hard copy of the preliminary Balance Report or an e-mailed copy to the Mechanical Contractor and Consultant a minimum of one week prior to the Occupancy Review.

.2 Provide six (6) copies of the final reports and two (2) electronic diskettes, covering air and water system performance and sound level readings prior to the Substantial Performance Review for the project. Final reports shall be sealed by a Professional Engineer or Certified Technologist.

.3 Types, serial numbers, and dates of calibration of all instruments shall be included.

.4 Reports shall contain a summary sheet to identify items not conforming to contract requirements, or obvious installation of design deficiencies.

.5 Forms used for Balancing Reports shall conform to industry standards and shall include all pertinent information for full evaluation of systems balancing. Reports are to be completed and are to contain the following:

.1 Name of Balancing Agency and Personnel
.2 Name of Project, Mechanical Contractor and date of balancing.
.3 Identification of systems and floor plan drawing schematics; maximum sheet size of 11"x 17”.
.4 Static pressure and volume measurements at each component.
.5 List of outlets and room numbers with (design and actual) volumes.
.6 Temperature readings (mixed air, outdoor supply, water, etc.) under varying conditions.
.7 Nameplate and measured electrical characteristics.
.8 Fan, pump and system pressure drops; and pump and fan curves.

.6 Submit a Statutory Declaration to the Owner, with a copy to the Consultant, stating that the testing and balancing has been completed prior to Occupancy and that complete factual reports have been distributed. The Declarations shall include a statement that all work and contractual deficiencies related to the balancing work have been completed by the Mechanical Contractor, and that follow-up testing and balancing has been completed after the corrections of all outstanding work and deficiencies.

3.7 FINAL TESTS, INSPECTIONS AND ACCEPTANCE

.1 Tests shall be made to demonstrate that capacities and performance of air and water systems comply with contract requirements.

.1 Prior to the Substantial Performance, the Consultant shall randomly select up to [20] outlets for the Testing and Balancing Contractor to recheck; random

selection of data (water and air quantities, air motion, and sound levels) recorded in the certified report.

.2 Measurement and test procedures shall be the same as approved for work forming basis of certified report.

.2 If random tests elicit a measured flow deviation of 5 percent or more from the values in the preliminary Balancing Report, then a further 10 random checks shall be carried out. If the 30 tests indicate unacceptable results, then the report shall be automatically rejected. In the event the report is rejected, all related equipment and systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost.

.3 The settings of all valves, splitters, dampers and other adjustment devices shall be permanently marked by the Testing and Balancing Contractor so that adjustment can be restored if disturbed at any time.

.4 Schedule with the Owner and Consultant and allow for [two (2)] site visits during the warranty period to make minor seasonal adjustments after occupancy that may be required; each visit to be a minimum of six (6) hours. Submit report of findings to the Owner and Consultant after each site visit.

END OF SECTION

1. General

.1 This Section of the Specification forms part of the Contract Documents and shall be read, interpreted and coordinated with all other parts.

.2 Related work to other sections include:

.1 Section 01 91 13 – General Commissioning Requirements.

.2 Section 01 91 31 – Commissioning Plan

.3 Section 01 91 33 – Commissioning Forms

.4 Sections 01 91 41 – Commissioning Training

.5 Section 23 08 01 Performance Verification Mechanical Piping Systems

.6 Section 23 08 02 Cleaning and Start-Up of Mechanical Piping Systems

.7 Section 23 05 93 Testing, Adjusting and Balancing

.8 Coordination of electrical interface items with the equipment and controls, including work specified in Division 26 related to mechanical systems.

.3 The Commissioning Team shall include the Commissioning Authority, Contractor's Commissioning Agent, Mechanical Contractor, Controls Contractor, the Balancing Contractor, Fire Protection Contractor, and other selected trades persons, manufacturers' representatives; the Consultants, and Owner's representatives who will also participate in the commissioning process.

.4 Building Commissioning work is a joint team effort to ensure that all mechanical equipment, controls, and systems function together properly to meet the design intent and to document system performance parameters or fine-tuning of control sequences and operational procedures. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, and performance testing and verification.

.5 The Commissioning Authority will have responsibility for coordinating and directing each step of the commissioning process; and for recommending acceptance or non-acceptance to the Consultant and Owner.

.6 The Commissioning Agent's scope of work for the HVAC, Plumbing and Fire Protection Systems, is but not limited to, the following:

.1 Review of related Contract Documents and submit comments to the Consultant.
.2 Develop and submit a commissioning plan with detailed checklists and schedule.
.3 Schedule and coordinate a construction site meeting soon after construction has started.

.4 Record and distribute commissioning meeting minutes.

.5 Review of shop drawings and site installations.

.6 Confirm that Start-up Activation has been carried to code and industry standards.

.7 Participate in Start-up / Activation process; issue deficiency lists.

.8 Overview of Balancing; and Controls System installation.

.9 Detailed review of Systems Operation prior to the Substantial Review.

.10 Coordinate the Orientation and Demonstration Session(s) for the Owners.

.11 Follow-up visits during the Warranty period and submit reports to the Contractor, Owner and Consultant after each visit.

.12 Submit a final report at the end of the Warranty period.

.7 The Contractor and Commissioning Agent shall submit the names of representatives of the Commissioning Team for the Consultant's review at an early stage of construction. Within ninety (90) days after award of his contract the Commissioning Agent shall submit detailed descriptions of test and verification procedures with a schedule, to the Contractor, Owner and Consultant, for the commissioning work of systems and components. The Commissioning Agent shall be responsible for conducting commissioning meetings and issuing minutes and action lists to the Contractors and Consultants.

.8 The Contractor and his sub-trades shall be responsible for the actual system Functional Performance testing. Documentation of this testing and any changes to the approved test procedures must be approved by the Commissioning Agent.

.9 The Commissioning plan shall contain the information necessary to document the commissioning process as it progresses from the pre-start checks, to start-up and initial operation, and finally to functional performances verifications of all systems. The Commissioning Plan shall include procedures and detailed checklist relevant to:

.1 Initial Meeting: The Contractor and Commissioning Agent to schedule the initial meeting prior to installation of mechanical systems.

.2 System Readiness and Start-up: This includes typical checks for pressure testing, cleaning, lubrication, equipment drive alignment, motor rotation check safety devices and control point check.

.3 Initial Operation: The Contractor and Commissioning Agent complete the testing, balancing and calibration of all components and systems. The systems are operated through the specified modes of operation; tests carried out on life and safety systems including emergency conditions.

.4 Functional Performance Verification: All equipment and systems are operated through the entire specified sequence of operation so that the Consultant may witness and verify acceptable operation on a selected or total basis. There maybe two separate periods required –one during the heating season and one during the cooling season.

.5 Orientations and Demonstration: This is provided to the Owner's representative(s) after all the above phases are completed.

.6 Warranty Period: The follow-up shall consist of regular site visits with a minimum of 3 visits during the Warranty Period with reports submitted to the Owner, Contractor and Consultant.

2. Commissioning Process

.1 A commissioning scoping meeting of all members of the commissioning scoping meeting of all members of the commissioning team shall be held at a time and place designated by the Owner or his representative. The purpose of the meeting will be to familiarize all parties with the requirements of the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

.2 There are two distinct types of tests for which the Contractor is responsible.

.1 The first type is the Pre-functional Performance Test. These tests ensure that all equipment and systems are installed in accordance with the Specifications, Drawings, and manufacturers' requirements.

.2 The second type of test is the Functional Performance Test. These tests ensure that all equipment and systems operate in accordance with design intent. These are dynamic tests, and test the systems through all possible modes of operation.

.3 The functional performance testing shall be done during two separate periods – one during the cooling season and one during the heating season. The cooling testing period shall occur as soon as the weather conditions permit to test the cooling systems. The heating testing period shall occur as soon as weather conditions make it practical to test warm-up, zone reheat, and economizer functions.

2.1 SYSTEM START-UP AND TESTING

.1 Operating equipment and systems shall be tested in presence of Commissioning Agent (and the Consultant at his option) to demonstrate compliance with specified requirements.

.2 Notify Commissioning Agent, in writing, fourteen (14) days prior to tests scheduled under requirements of this Section.

.3 Testing shall be conducted under specified design operating conditions as recommended or approved by Commissioning Agent and Consultant.

.4 All elements of systems shall be tested to demonstrate the total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each subsystem, followed by entire system, followed by any interfaces to other major systems.

.5 All special testing materials and equipment shall be provided by Contractor.

2.2 TEST PROCEDURE DEVELOPMENT AND TEST DOCUMENTATION

.1 Within 90 (ninety) days after award of the Contract, the Contractor shall prepare and submit to Commissioning Agent and Consultant for review, a detailed description of test procedures which the Contractor proposes to perform to demonstrate conformance of completed systems to these Specifications.

2.3 PRE-FUNCTIONAL PERFORMANCE TEST

.1 Coordinate schedules for start-up of various equipment and systems. The pre-functional performance tests need be performed once only-prior to the initial seasonal functional performance testing.

.2 Each system shall be checked for proper installation, shall be adjusted, and shall be calibrated to verify that it is ready to function as specified.

.3 All system elements shall be checked to verify that they have been installed properly and that all connections have been made correctly. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence or other conditions which may cause damage.

.4 Verify that tests, meter readings and specific electrical characteristics agree with those required by equipment or system manufacturer.

.5 All discrete elements and sub-systems shall be adjusted and shall be checked for proper operation. Verify wiring and support components for equipment are complete and tested.

.6 Verification of complete and proper installation shall be completed prior to starting Functional Performance Tests.

.7 Pre-functional performance tests shall be documented in a checklist format for each system/piece of equipment. Each checklist shall be dated and initialled by the Contractor.

2.4 FUNCTIONAL PERFORMANCE TEST

.1 The objective of these is to demonstrate that each system is operating and complying with specified performance requirements through all possible modes of operation.

.2 A functional Performance Test shall be performed on each complete system. Each function shall be demonstrated to satisfaction of the Commissioning Agent on a paragraph-by-paragraph basis of Contractor's written test procedure, developed to demonstrate conformance to requirements of Contract Specifications and the Design Intent Document.

.3 Each functional performance test shall be witnessed and signed off by the Commissioning Agent and Consultant upon satisfactory completion.

.4 Actual testing program shall be conducted in accordance with prior approved procedures and shall be documented as required hereinafter.

.5 Notify Commissioning Agent at least two weeks prior to date of functional performance tests. Schedule each of the two seasonal functional performance test periods over a single block of days.

2.5 SCOPE OF WORK

.1 Commissioning of systems is concluded when all mechanical systems are in full working order and acceptable for use prior to the Occupancy and Substantial Performance Review.

The commissioning work shall include, but not limited to confirmation of the following by the Mechanical Contractor and Commissioning Agent:

.1 Completion of the Documentation as per Section 23 08 01 Performance Verification Mechanical Piping Systems and Commissioning Reports.

.2 Confirmation that start-up procedures have been completed by the Contractors, such as:

- .1 Lubrication
- .2 Chemical cleaning of piping systems
- .3 Adjusting and aligning drives
- .4 Checking equipment rotation
- .5 Adjusting vibration isolation
- .6 Equipment start up
- .7 Certification of special systems
- .8 Seismic restraints installed

.3 Confirmation of any sound level issues.

.4 Confirmation of balancing of the air and water systems.

.5 All automatic control valves/dampers and automatic temperature control devices have been checked out and are functional; co-ordinate with the Controls Contractor.

.6 Set-up, review and test alarm and protective devices with the Sprinkler and Electrical Contractors.

.7 Assist in trouble shooting and resolution of problems.

.8 Complete the work detailed on the lists required by the commissioning process.

.9 Confirmation of completion of Manufacturer's equipment commissioning procedures carried out by Sub-Trades/Technicians / Manufacturer representatives.

.10 Verification of all systems functional performance tests.

.11 Review of the Record Drawings and Maintenance Manuals.

.12 Owner's Orientation and Demonstration schedule confirmed.

.13 Follow-up visits during the warranty period.

2.6 COMMISSIONING CHECKLISTS AND REPORTS

.1 The design of the project checklists, to be prepared by the Commissioning Agent, should be such that the items to be checked are identified and the steps taken in functional performance testing are clearly listed. The documentation should be such that the process can be repeated in the future with similar results obtained. A draft of the Commissioning report and check lists to be submitted to the Consultant for review prior to start of work.

3. Execution

3.1 GENERAL DOCUMENTATION

.1 The Contractor shall record and maintain detailed inspection and testing data. The data record shall be comprehensive and concise.

.2 All data must be recorded as soon as possible during the course of the inspection and testing.

.3 All documentation shall have the date, time, and names of persons participating in the inspection and testing.

.4 All test instruments shall be documented for valid calibration.

.5 The recording work sheets, inspection check lists, and performance testing plans must all be approved by the Consultant and Commissioning Agent prior to the start of functional performance testing.

3.2 THE COMMISSIONING AGENT SHALL PREPARE AND SUBMIT THE FOLLOWING REPORTS

.1 Interim Report. Submit after completion of initial commissioning period. Report shall document tests performed, and modifications to tests, comparison to TAB and other agency tests, and verification of compliance with design intent for ambient conditions under which initial commissioning was performed.

.2 Final Report. Submit after completion of seasonal commissioning. Report shall verify performance of mechanical equipment and systems during each seasonal commissioning process. Document any field modifications to the testing process and why these modifications were made.

3.3 FUNCTIONAL PERFORMANCE TEST PERSONNEL

.1 The following personnel are to be present during functional performance testing:

.1 The Contractor together with selected mechanical and controls subcontractors as relevant to specific test.

.2 Commissioning Agent.

.3 Owner’s representative, Consultant, and Architect may be present for some or all of functional performance testing.

3.4 VERIFICATION

.1 Commissioning functional performance tests shall begin after mechanical systems equipment and systems, along with related equipment, systems, structures, and areas are complete.

.2 Verify test air balance (TAB) readings for at least 10 percent of the supply (maximum and minimum primary air), return, and exhaust diffusers, registers, and grilles. If more than one-fifth of these readings differ from the documented TAB readings by more than 10 percent, then the TAB shall be repeated in entirety.

.3 Verify that the total mechanical systems are performing to provide conditions through all possible modes of operation as outlined in the Design Intent Document (provided by the Consultants). The verification testing procedures shall address all operating characteristics of all mechanical equipment and systems for that system.

.4 Verify with the Controls Contractor the calibration all sensors and controllers, and verify proper operation of all valves, actuators, relays and other controlled devices. The Controls Contractor shall provide a calibration report with a separate page documenting the calibration of each sensor and controlled device.

3.5 FUNCTIONAL PERFORMANCE TEST CHECKLIST

.1 The Contractor and Commissioning Agent shall prepare the detailed checklists to organize and document the functional performance testing. A separate checklist is required for each of the equipment/systems. The sample checklist shall be provided to the Consultant for review as an example of the level of detail and logical approach required in the functional performance test checklists.

3.6 RESULTS

.1 The Commissioning Agent shall document the functional performance test results obtained. If any tests have to be modified to accommodate as-built conditions, these modifications must be documented. All documentation shall be submitted to the Consultant for approval.

.2 If specified equipment and system performance is not verified, the Commissioning Agent will coordinate remedial action required and reschedule the functional performance test

.3 At the completion of the commissioning process the: Contractor and the Commissioning Agent shall submit the following to the Consultant:

- .1 A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings and submission of all documents.
- .2 As-Built Drawings and Maintenance Manuals reviewed and submitted.
- .3 A letter from the testing and balancing agency certifying that all necessary data for inclusion in operating and maintenance manuals has been received.
- .4 A list of all alarm and protective devices tested, with the final operating settings confirmed.
- .5 Four (4) copies of the final Commissioning Report and completed checklists.
- .6 Written confirmation that the Owner's representatives have received orientation and demonstration instructions

.4 Demonstrate the operation of the system to the Owner’s representatives; the operating and maintenance manuals shall be available for the demonstration period. The seminar shall be attended by the Contractor and Sub-trades, Consultant, Suppliers, Balancing Contractor, Control Contractor; also the Sprinkler Contractor and Electrical Contractor for all or part of the seminar. This demonstration shall include but not be limited, to:

- .1 Location of and opening/closing of typical access panels.
- .2 Operation of all automatic control dampers and automatic temperature control devices.
- .3 Operation of all alarm and protective devices.
- .4 Proper response of all air valves to thermostats and volume adjustment controls.
- .5 Operability of randomly selected fire dampers.

.6 Operation of all equipment and systems under each mode of operating, and failure, including but not limited to:

.1 Complete plumbing systems.

.2 HVAC equipment and systems.

.3 Exhaust fans.

.4 Supply fans.

.5 Fire protection systems and smoke systems.

.6 Fire dampers locations (typical).

.7 Heating and cooling systems.

.8 Valve locations, tagging and identification

.9 Energy conservation management.

.10 Confirm tools and spare parts handed to the Owners.

.5 The Commissioning Agent shall carry out following visits and provide reports, during the Warranty Period; prior to the visits confirm date of visits with the Contractor, Owner and the Consultant. After each visit forward a copy of the report to the Contractor, Owner and Consultant.

.1 Within one month of Occupancy to confirm that all deficiencies have been completed and that the Owner's Operations personnel (or a maintenance firm) are properly maintaining and operating the mechanical systems.

.2 The next site visit to be within 6 months and a review of the mechanical systems operations and maintenance carried out including seasonal adjustments in the operation of the mechanical system.

.3 At the end of the warranty period do a final report and identify any outstanding mechanical and/or user complaints.

END OF SECTION

1. General

1.1 SUMMARY

.1 Related Sections:

.1 Section 01 30 00 - Administrative Requirements.
.2 Section 01 40 00 - Quality Requirements.
.3 Section 01 60 00 - Product Requirements.
.4 Section 01 70 00 - Execution and Closeout Requirement.
.5 Section 01 74 19 - Waste Management and Disposal.
.6 Section 23 05 00 - Common Work Results – HVAC

1.2 REFERENCES

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

.1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
.1 Pump operation.
.2 Pressure bypass open/closed.
.3 Control pressure failure.
.4 Maximum heating demand.

1.5 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed
.2 Verification of operating, limit, safety controls.
.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.2 Test procedures:

.1 Open fully heat exchanger, heating coil and radiation control valves.

.2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

.3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.6 REPORTS

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

1.7 TRAINING

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

END OF SECTION

1. General

1.1 SUMMARY

.1 Section Includes:

.1 Procedures and cleaning solutions for cleaning mechanical piping systems.

.2 Sustainable requirements for construction and verification.

.3 Related Sections:

.1 Section 01 30 00 - Administrative Requirements.
.2 Section 01 40 00 - Quality Requirements.
.3 Section 01 60 00 - Product Requirements.
.4 Section 01 70 00 - Execution and Closeout Requirement.
.5 Section 01 74 19 - Waste Management and Disposal.
.6 Section 23 05 00 - Common Work Results – HVAC

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 in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Instructions: submit manufacturer's installation instructions.

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

2. Products

2.1 SUSTAINABLE REQUIREMENTS

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

2.2 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.

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 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 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.

.6 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.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to maximum design temperature, 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 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.7 Repeat with water at design temperature.

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

.9 Bring system up to design temperature and pressure slowly over a 48 hour period.

.10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.11 Adjust pipe supports, hangers, springs as necessary.

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

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

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

.15 Check operation of drain valves.

.16 Adjust valve stem packings as systems settle down.

.17 Fully open balancing valves (except those that are factory-set).

.18 Check operation of over-temperature protection devices on circulating pumps.

.19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 FIELD QUALITY CONTROL

.1 Contractor's Verification, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.5 CLEANING

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

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

END OF SECTION

1. General

1.1 SUMMARY

.1 Section Includes:

.1 Copper piping valves and fittings for hydronic systems.

.2 Related Sections:

.1 Section 01 40 00 - Quality Requirements.
.2 Section 01 60 00 - Product Requirements.
.3 Section 01 70 00 - Execution and Closeout Requirement.
.4 Section 01 74 19 - Waste Management and Disposal.
.5 Section 23 05 00 - Common Work Results – HVAC.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)

.1 ANSI/AWS A5.8/A5.8M-04, Specification Filler Metals for Brazing and Bronze Welding.

.2 American Society of Mechanical Engineers (ASME)

.1 ANSI/ASME B16.4-98, Gray-Iron Threaded Fittings.
.2 ANSI/ASME B16.15-1985(2004), Cast Bronze Threaded Fittings.
.3 ANSI B16.18-2001, Cast Copper Alloy, Solder Joint Pressure Fittings.
.4 ANSI/ASME B16.22-2001, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.

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

.1 ASTM B32-04, Standard Specification for Solder Metal.
.2 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
.3 ASTM B62-02 Standard Specification for Composition Bronze or Ounce Metal Castings.
.4 ASTM B88M-03, Standard Specification for Seamless Copper Water Tube [Metric].
.5 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.5 Manufacturers Standardization Society (MSS)

.1 MSS SP67-2002a, Butterfly Valves.
.2 MSS SP70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
.3 MSS SP71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS SP80-2003, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS SP85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

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 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.1 Shop drawings: submit drawings.

.2 Indicate on manufacturers catalogue literature the following: VALVES.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

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

.4 Closeout Submittals:

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

1.4 QUALITY ASSURANCE

.1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.

.2 Health and Safety:

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

1.5 MAINTENANCE

.1 Extra Materials:

.1 Furnish following spare parts:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: two of each size.

.5 Gaskets for flanges: one for every ten flanges.

2. Products

2.1 TUBING

.1 Type L hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

.1 Cast bronze threaded fittings: to ANSI/ASME B16.15.

.2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.

.3 Cast iron threaded fittings: to ANSI/ASME B16.4.

.4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

.5 NPS 2 and larger: roll grooved to CSA B242. Fittings shall be wrought copper to ANSI/ASME B16.22 or cast bronze to ANSI/ASME B16.18, with copper-tube dimensioned grooved ends. (Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.) Basis of Design: Victaulic Copper-Connection.

2.3 FLANGES

.1 Brass or bronze: threaded.

.2 Cast iron: threaded.

.3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

.1 Solder, tin-antimony, 95:5: to ASTM B32.

.2 Silver solder BCUP: to ANSI/AWS A5.8.

.3 Brazing: as indicated.

.4 Grooved couplings: Only allowed for chilled water system. Heating water system shall be brazed. Grooved couplings designed with angle bolt pads to provide rigid joint at copper-tubing sizes, complete with EPDM-HP flush seal type gasket, suitable for water temperatures to +250 deg F. Installation-Ready, for direct stab installation without field disassembly. Basis of Design: Victaulic Style 607H.

.5 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner. Basis of Design: Victaulic Style 47.

2.5 VALVES

.1 Connections:

.1 NPS 2 and smaller: ends for soldering.

.2 NPS 2 1/2 and larger: copper-tube dimensioned grooved ends.

.2 Gate Valves: Application: isolating equipment:

.1 NPS 2 and under:

.1 Mechanical Rooms: Class 125, rising stem split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.3 Butterfly valves: application: isolating each cell or section of multiple component equipment (eg. multi-section coils, multi-cell cooling towers):

.1 NPS 2 1/2 and over: lug type or grooved ends

.2 Basis of Design: Victaulic Style 608

.4 Globe valves: application: throttling, flow control, emergency bypass:

.1 NPS 2 and under:

.1 Mechanical Rooms: with PFTE disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 1/2 and over:

.1 With composition or bronze disc, bronze trim

.2 Operators: Provide chain operators where valves are installed at or above 4 meters above finished floor.

.5 Balancing, for TAB:

.1 Sizes: calibrated balancing valves, as specified.

.2 NPS 2 and under:

.1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.

.6 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.7 Bypass valves on globe valves NPS 8 and larger: NPS 3/4, globe, with PFTE disc as specified Section 23 05 23.01 - Valves - Bronze.

.8 Swing check valves:

.1 NPS 2 and under:

.1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 1/2 and over:

.1 Flanged or Grooved ends

.2 NPS 2 and under:

.1 As specified Section 23 05 23.01 - Valves - Bronze.

.3 NPS 2 1/2 and over:

.1 Flanged or Grooved ends

.9 Ball valves:

.1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

.10 Lubricated Plug Valves:

.1 NPS 2 1/2 and over.

3. Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING INSTALLATION

.1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.

.3 Slope piping in direction of drainage and for positive venting.

.4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.6 Assemble piping using fittings manufactured to ANSI standards.

.7 Grooved joint shall be installed in accordance with the manufacturer’s written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer’s factory trained representative shall provide on-site training for the contractor’s field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor’s representative is not considered qualified to conduct the training.)

3.3 VALVE INSTALLATION

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

.2 Install butterfly valves on chilled water and condenser water lines only.

.3 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.4 Install globe valves for balancing and in by-pass around control valves as indicated.

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

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

.7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

3.4 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and TAB is complete.

3.5 FLUSHING AND CLEANING

.1 Flush and clean in presence of Consultant.

.2 Flush after pressure test for a minimum of 4h.

.3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8h.

.4 Refill system with clean water. Circulate for at least 4h. Clean out strainer screens/baskets regularly. Then drain.

.5 Refill system with clean water. Circulate for at least 2h. Clean out strainer screens/baskets regularly. Then drain.

.6 Drainage to include drain valves, dirt pockets, strainers, low points in system.

.7 Re-install strainer screens/baskets only after obtaining Consultant's approval.

3.6 FILLING OF SYSTEM

.1 Refill system with clean water adding water treatment as specified.

3.7 FIELD QUALITY CONTROL

.1 Testing:

.1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

.2 Balancing:

.1 Balance water systems to within plus or minus 5% of design output.

3.8 CLEANING

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

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

END OF SECTION

1. General

1.1 SUMMARY

.1 Section Includes.

.1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.

.2 Related Sections.

.1 Section 01 40 00 - Quality Requirements.
.2 Section 01 60 00 - Product Requirements.
.3 Section 01 70 00 - Execution and Closeout Requirement.
.4 Section 01 74 19 - Waste Management and Disposal.
.5 Section 23 05 00 - Common Work Results – HVAC.
.6 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
.7 Section 23 08 01 - Performance Verification of Mechanical Piping.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
.2 ASME B16.3-98, Malleable Iron Threaded Fittings.
.3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
.4 ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.
.5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
.6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).

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

.1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
.2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
.3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
.4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
.5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
.6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.3 American Water Works Association (AWWA).

.1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).

.1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.

.2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

.5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).

.1 MSS-SP-67-025, Butterfly Valves.

.2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.

.4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Grooved joint couplings and fittings may be shown on drawings and product submittals, and shall be specifically identified by the manufacturer’s style or series designation.

.3 Closeout Submittals.

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

.1 Special servicing requirements.

1.4 MAINTENANCE

.1 Extra Materials.

.1 Provide following spare parts:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: two of each size.

.5 Gaskets for flanges: one for every ten flanges.

2. Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, ASTM A120 Grade A.

.2 Stainless steel pipe: Sch.10S, ASTM A312, Type 304/304L.

2.2 PIPE JOINTS

.1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.

.2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.

.3 Roll grooved: standard/rigid coupling to CSA B242.

.4 Flanges: plain or raised face, slip-on weld neck to AWWA C111.

.5 Orifice flanges: slip-on raised face, 2100 kPa.

.6 Flange gaskets: to AWWA C111.

.7 Pipe thread: taper.

.8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

.9 Roll grooved: Grooved couplings only allowed for chilled water system. Heating water system shall be welded or screwed. Grooved joint couplings shall consist of two ductile iron housing segments to ASTM A536, pressure responsive gasket to ASTM D2000, type EPDM / EPDM-HP, and zinc electroplated steel bolts and nuts to ASTM A449. Couplings shall comply with CSA B242. Rigid Type: Coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.

.1 Victaulic Style 107H, Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket, suitable for water service to +250 deg F.

.2 Victaulic Style 07 “Zero-Flex”

.2 Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors. Victaulic Installation-Ready Style 177 or Style 77.

.3 14” and Larger: AGS Series, with lead-in chamfer on housing key and wide width FlushSeal gasket. Victaulic Style W07 (rigid) and Style W77 (flexible).

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:

.1 Cast iron: to ASME B16.1, Class 125.

.2 Steel: to ASME B16.5.

.3 Butt-welding fittings: steel, to ASME B16.9.

.4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

.1 Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings. (The couplings shall serve as disconnect points.)

.5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M; ductile iron to ASTM A536; wrought steel to ASTM A234; and factory-fabricated from steel pipe conforming to ASTM A53

.6 Stainless steel fittings: Precision, cold drawn, stainless steel with HNBR or EPDM seals, rated to 3450-kPa [500 psig] CWP. Basis of Design: Victaulic Vic-Press 304 for Schedule 10S Pipe.

2.4 VALVES

.1 Connections:

.1 NPS2 and smaller: screwed or Vic-Press ends.

.2 NPS2.1/2 and larger: Flanged or grooved ends.

.2 Gate valves: to MSS-SP-70 and MSS-SP-80. Application: Isolating equipment, control valves, pipelines.:

.1 NPS2 and under:

.1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS21/2 and over:

.1 Mechanical Rooms: rising stem, split wedge disc, lead free bronze trim

.1 Operators: Provide chain operators where valves are installed at or above 4 meters above finished floor..

.2 Elsewhere: Non-rising stem, solid wedge disc, lead free bronze trim

.1 Operators: Provide chain operators where valves are installed at or above 4 meters above finished floor..

.3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment (e.g. multi-section coils, multi-cell cooling towers):

.1 NPS21/2 and over: Lug type Grooved ends

.4 Globe valves: to MSS-SP-80 Application: Throttling, flow control, emergency bypass:

.1 NPS2 and under:

.1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: Globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS21/2 and over:

.1 With composition lead free bronze disc, lead free bronze trim

.2 Operators: Provide chain operators where valves are installed at or above 4 meters above finished floor..

.5 Balancing, for TAB:

.1 Sizes: Calibrated balancing valves, as specified this section.

.2 NPS2 and under:

.1 Mechanical Room: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.

.2 Elsewhere: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.

.6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.7 Bypass valves on glove valves NPS 8 and larger: NPS3/4, Globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.

.8 Swing check valves: to MSS-SP-71.

.1 NPS2 and under:

.1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS21/2 and over:

.1 Flanged or Grooved ends

.9 Silent check valves:

.1 NPS2 and under:

.1 As specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS21/2 and over:

.1 Flanged or Grooved ends

.10 Ball valves:

.1 NPS2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

3. Execution

3.1 PIPING INSTALLATION

.1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.

.2 Grooved couplings only allowed for chilled water system. Heating water system shall be welded or screwed. Grooved joint shall be installed in accordance with the manufacturer's written recommendations. Grooved ends shall be clean and free from indentations, projections, or roll marks. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. (A distributor's representative is not considered qualified to conduct the training.).

3.2 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and when TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 CLEANING, FLUSHING AND START-UP

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

3.4 TESTING

.1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.

3.5 BALANCING

.1 Balance water systems to within plus or minus 5% of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.6 PERFORMANCE VERIFICATION

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

3.7 CLEANING

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

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

END OF SECTION

1. General

1.1 RELATED REQUIREMENTS

.1 Section 01 30 00 - Administrative Requirements.

.2 Section 01 40 00 - Quality Requirements.

.3 Section 01 60 00 - Product Requirements.

.4 Section 01 70 00 - Execution and Closeout Requirement.

.5 Section 01 74 19 - Waste Management and Disposal.

.6 Section 23 05 00 - Common Work Results – HVAC.

1.2 REFERENCES

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers Advisory Council (EEMAC)

.3 Canadian Standards Association (CSA International)

.1 CSA-B214-07, Installation Code for Hydronic Heating Systems.

.4 National Electrical Manufacturers' Association (NEMA)

.1 NEMA MG 1-2006, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.

.3 Shop Drawings:

.1 Provide drawings.

.4 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Supply spare parts as follows: .

2. Products

2.2 GENERAL

1. Statically and dynamically balance rotating parts.
2. Construction shall permit complete servicing without breaking piping or motor connections.
3. Pumps shall operate at 1750 rpm unless specified otherwise.
4. Pump connections shall be flanged for sizes 65 mm (2½") and larger.
5. Heating pumps shall be suitable for handling water at 110°C (230°F).

2.3 IN-LINE CIRCULATORS

1. Casing: Bronze or cast iron rated at 150 psi (1034) kPa) or 1.25 times actual working pressure.
2. Impeller: Bronze or cadmium plated steel.
3. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.
4. Seals: Watertight mechanical with ceramic ring rotating against carbon face; suitable for 135°C (275°F) service.
5. Motor: Resiliently mounted motor with spring type coupling.
6. Domestic Water Service: All bronze or stainless steel.

2.5 VERTICAL IN-LINE PUMPS

1. Type: Centrifugal, single stage, closed coupled or split coupled in-line pullout design, suitable for horizontal or vertical operation; tapped openings for venting and drainage.
2. Casing: Cast iron, rated for greater of 150 psi (1034 kPa) or 1.25 times actual discharge working pressure, suction and discharge gauge port, air vent, wear rings, seal flush connection, drain plug, flanged suction and discharge.
3. Impeller: Bronze or cast iron, fully enclosed, keyed to shaft and secured with lockout.

4. Shaft: Stainless steel or carbon steel with bronze or stainless steel sleeve through seal chamber and integral thrust collar.

5. Seals: Carbon rotating against a stationary seat (Crane Type 21); suitable for 135°C service; Viton/Ceramic or equivalent.

6. Motor: Resilient mounted, drip-proof, sleeve bearing with self-aligning coupling.

2.6 PUMP DISCHARGE TRIPLE COMBINATION VALVES

1. Installed minimum of five pipe diameters from pumps, elbows or source of turbulence.

2. Combination drip-tight shut-off valve, stainless steel spring closure non-slam check valve and flow throttling valve.

3. Two 6 mm (¼“) ports on each side of valve seat; two connections to have brass pressure and temperature metering ports with valves and gasketed caps. The two other connections to have brass caps.

4. Ductile valve body with grooved ends and anti-rotation lugs on inlet and outlet of valve body.

5. Valve disc shall be bronze plug disk type with high impact resin seat for tight shut-off and silent check valve operation.

6. Stainless steel valve stem with flat surfaces for open end wrench adjustments; grooved rings and positioning sleeve.

7. Flange adapters as required with anti-rotation lugs and EPT gaskets.

8. Bonnet “O” ring replacement can be replaced under full system pressure.

9. Rated at 2586 kPa (375 psig) at 110ºC (230ºF).

10. Armstrong Model FTV Flo-Trex combination valve or approved equivalent; where grooved end system is used, incorporate Victaulic Triple Service Assembly.

11. For chilled water installations provide removable pre-formed removable PVC insulation jacket with mineral fibreglass insulation.

12. Installed to manufacturer’s recommendation.

3 Execution

3.2 PUMP INSTALLATION

1. General:

   .1 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer’s installation instructions for details.

   .2 Pipe drain tapping into floor drain.

.3 Install volute venting pet cock in accessible location.

.4 Check rotation prior to start-up.

.5 Install pressure gauge test cocks on suction and discharge.

.6 Check oil levels and lubricate.

.7 Provide line sized gate or butterfly valve and strainer on suction and line sized soft seated check valve and globe or butterfly valve on discharge.

.8 Decrease from line size, with long radius reducing elbows or reducers at pump.

.9 Provide flanged long radius elbow or 300 mm (12") spool on suction to permit future access to impeller without removing motor.

.10 For base-mounted pumps and floor mounted in-line pumps the Contractor may use the following; installed to manufacturer's recommendations:

1. Suction Guides: Victaulic style 731 Suction Guide or Armstrong Series SG or equivalent can be used on pump suction.

.1 Pump Discharge Assembly: Victaulic Triple Service Valve assembly, Armstrong Series FTA Flow-Trex or equivalent on pump discharge.

.11 Provide circuit balancing valve on all pumps, Tour and Anderson CBV or equivalent where triple service valve assemblies are not used.

.2 In-line Circulators:

.1 Install as indicated by flow arrows.

.2 Support at inlet and outlet flanges or unions.

.3 Install with bearing lubrication points accessible.

.3 Base Mounted Type:

.1 Supply templates for anchor bolt placement.

.2 Furnish anchor bolts with sleeves.

.3 Place level, shim unit and grout.

.4 Align coupling in accordance with manufacturer's recommended tolerance.

.4 Vibration Isolation:

.1 Pump assemblies mounted with isolation shall be provided with flexible type connectors or Victaulic connectors installed to the manufacturer's recommendation.

.5 Side Arm Filters:

.1 Provide side arm filter around pumps to filter up to 10% of pump capacity complete with isolation valves and flow indicator.

3.3 ` VORTEX AIR SEPARATORS

1. Provide as required to remove air from water and glycol systems.

3.5 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; supplemented as specified herein.

.2 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper, safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run-in pumps for 12 continuous hours minimum.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

3.6 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Provide written and signed report that itemizes, documents and verifies performance as described above.

.2 Verify that manufacturer's performance curves are accurate.

.3 Ensure valves on pump suction and discharge provide tight shut-off.

.4 Net Positive Suction Head (NPSH):

.1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.

.2 Measure using procedures prescribed in Section 23 08 00 Mechanical Systems Commissioning.

.3 Where procedures do not exist, discontinue PV, report to Consultant and await instructions.

.5 Multiple Pump Installations - Series and Parallel:

.1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.

.6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.

.7 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements reports supplemented as specified herein. Reports to include:

.1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.

.2 Use Report Forms specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.

.3 Pump performance curves (family of curves).

3.7 OPERATION REQUIREMENTS

.1 Operational requirements in accordance with Section 01 47 19 - Sustainable Requirements: Operations, include:

.1 Repair and maintenance materials and instructions.

3.8 CLEANING

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

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1 (21tst Edition), Safety Standard for Electrical Installations.

.2 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

.1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.2 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 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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings:

.1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure coordinated installation.

.2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

.3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

.4 Submit copies of 600 x 600 mm minimum size drawings and product data to authority having jurisdiction.

.5 If changes are required, notify Departmental Representative of these changes before they are made.

.3 Quality Control: in accordance with Section 01 45 00 - Quality Control. Provide CSA certified equipment and material.

.1 Where CSA certified material is not available, submit such material to authority having jurisdiction for special approval before delivery to site.

.2 Submit test results of installed electrical systems and instrumentation.

.3 Permits and fees: in accordance with General Conditions of contract.

.4 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

.4 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.5 QUALITY ASSURANCE

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

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Contractor license or apprentices in accordance per the conditions of Provincial Act respecting manpower vocational training and qualification.

.3 Site Meetings:

.1 In accordance with Section 01 32 17 - Construction Progress Schedule - Bar (GANTT) Charts.

.2 Site Meetings: as part of Manufacturer's Field Services described in Part 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.

.1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of Work, after cleaning is carried out.

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.7 SYSTEM STARTUP

.1 Instruct Departmental Representative in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant will aspects of its care and operation.

1.8 OPERATING INSTRUCTIONS

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.3 Safety precautions.

.4 Procedures to be followed in event of equipment failure.

.5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.9 RECORD DRAWINGS

.1 In addition to requirements for record drawings noted in Section 01 78 00 - Closeout Submittal, the following shall also be completed as per 01 78 00 - 1.4.3:

.1 Complete, detailed single line, three line and wiring diagrams for all new equipment installed as part of this project.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

.1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.

.2 Material and equipment to be CSA certified. Where CSA certified material and equipment is are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.

.3 Factory assemble control panels and component assemblies.

2.2 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of inspection authorities.

.2 Decal signs, minimum size 175 x 250 mm.

2.3 WIRING TERMINATIONS

.1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.4 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core.

.2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.

.3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacture.

.4 Allow for minimum of twenty-five (25) letters per nameplate and label.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

.8 Transformers: indicate capacity, primary and secondary voltages.

2.5 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, numbered, 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.

2.6 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.7 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Paint outdoor electrical equipment light gray to EEMAC 2Y-1.

.2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

Part 3 Execution

3.1 INSTALLATION

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

.2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

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

3.3 CONDUIT AND CABLE INSTALLATION

.1 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.2 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

3.5 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.6 FIELD QUALITY CONTROL

.1 Load Balance:

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.

.1 Power distribution system including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its control.

.4 Motors, heaters and associated control equipment including sequenced operation of systems.

.5 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.3 Carry out tests in presence of Departmental Representative.

.4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.5 Manufacturer's Field Services:

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

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

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

3.7 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect grounding equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 EQUIPMENT

.1 Insulated grounding conductors: green, copper conductors, size as indicated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.

.2 Install connectors in accordance with manufacturer's instructions.

.3 Protect exposed grounding conductors from mechanical injury.

.4 Use mechanical connectors for grounding connections to equipment provided with lugs.

.5 Soldered joints not permitted.

3.3 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral.

3.4 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies rigid and flexible conduits, fasteners, fittings and installation.

1.2 REFERENCES

.1 Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware: to CSA C22.2 No. 18.

.2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.

.3 Flexible metal conduit (FMC): to CSA C22.2 No. 56.

1.3 BASIC WIRING METHODS

.1 Underground or in concrete exterior to building:

.1 All wiring shall be in Schedule 40 RPVC conduit.

.2 Partition walls and ceilings:

.1 All wiring to be run in EMT conduit for:

.1 Branch circuits.

.2 Low voltage systems.

.3 Distribution feeders and sub-feeders.

.4 Surface wiring in electrical and mechanical rooms.

.3 Motors, transformers and all vibrating equipment:

.1 Short (600mm to 1200mm) PVC jacketed flexible conduit with liquid tight connectors shall be used. Allow sufficient slack to avoid strain on connectors at extreme extension of equipment movement.

.4 Surface raceways - interior:

.1 All surface raceways shall be EMT, except if located without protection in areas susceptible to damage, which shall be rigid steel conduit.

.5 All wiring methods and devices installed in the greenhouse area shall be wet location rated and corrosion resistant.

1.4 LOCATION

.1 Electrical drawings are diagrammatic and do not show all conduits, wire, cable, etc. Electrical contractor to provide conduit, wire cable, etc., for a complete operating job to meet in all respects the intent of the drawings and specifications.

.2 Outlet positions shown on architectural drawings (plans and elevations) to take precedence over locations and mounting heights indicated on electrical plans or in specifications.

.3 Locate electrical devices on walls with regard given for convenience of operation and conservation of wall space. Switches, receptacles, fire alarm pull stations, etc. generally to be vertically lined up where items are in the same general location. Adjacent common devices to be installed in common outlet box.

.4 Review the exact location criteria of each electrical outlet and device with the Departmental Representative prior to rough-in. Relocate any item installed without this confirmation as required by the Departmental Representative at no

cost to the owner as long as the relocation is within 3m of the location originally shown on the electrical drawings.

.5 Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of door.

.6 All junction boxes and other raceway access devices shall be mounted to avoid being visible from public areas. Obtain approval from Departmental Representative for any and all junction boxes that, due to the building design, cannot be concealed.

.7 All junction boxes mounted, out of necessity, on surface of solid walls shall be painted to match adjacent surface, with junction boxes painted to match designated systems.

Part 2 Products

2.1 EMT RACEWAY

.1 Electrical Metallic Tubing (EMT) shall be galvanized steel of sufficient quality and thickness to allow smooth field formed bends.

.2 EMT couplings, connectors and fittings shall be steel. Cast type units shall not be used on this installation.

2.2 OUTLET BOXES AND JUNCTION BOXES

.1 Except as noted for rigid PVC raceways, all outlet boxes and junction boxes shall be one piece formed or welded.

.2 Outlet boxes to be galvanized steel.

.3 Junction boxes to be galvanized steel or aluminum.

2.3 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1500mm oc.

.4 Threaded rods, 6 mm dia., to support suspended channels.

2.4 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.

.3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

2.5 FISH CORD

.1 Polypropylene.

Part 3 Execution

3.1 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.3 Use electrical metallic tubing (EMT) except in cast concrete and above 2.4 m not subject to mechanical injury.

.4 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.

.5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.6 Minimum conduit size for lighting and power circuits: 19mm.

.7 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.8 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.9 Install fish cord in empty conduits.

.10 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.11 Dry conduits out before installing wire.

.12 Conduits shall be installed mechanically continuous from outlet to outlet and without pockets. All the necessary standard bushings, elbows and bends shall be provided. All conduit bends shall have a radius of not less than six (6) times the internal diameter of the conduit and in no case shall the equivalent of more than four quarter bends from outlet to outlet be made. For all conduit sizes to be used for low voltage raceway, the conduits shall have a minimum bending radius of 230mm.

.13 Conduit bends shall be made with no more than 10% flattening of the conduit. Bends shall be smooth throughout deformations.

.14 On surface wall runs, all conduit shall be installed in true vertical or horizontal direction and on ceilings in true 90 degree angles or parallel to the walls. Crossings of conduits shall also be made at 90 degree angles. Parallel running conduit shall be kept on equal spacing on the entire length of run including bends.

.15 All conduits shall be fastened to structure with steel straps (no cast type straps allowed).

.16 Where more than three conduits are run parallel in ceiling cavity, they shall be installed on cantruss type channel, complete with all Manufacturer's fittings to secure channel to structure and to conduit.

.17 Raceways extending out concrete slabs shall be securely protected using rebar stubs or similar material. All duct stubs are to be kept sealed during construction

3.2 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include time-current characteristic curves for breakers with ampacity of 100A and over.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers, to CSA C22.2 No. 5

.2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.5 Circuit breakers with interchangeable trips as indicated.

.6 Circuit breakers to have minimum 10kA symmetrical rms interrupting capacity rating.

2.2 THERMAL MAGNETIC BREAKERS

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 OPTIONAL FEATURES

.1 Include:

.1 Handle mechanism.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers in new or existing distribution assemblies as noted in drawings.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies materials and installation for fused and non-fused disconnect switches.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CAN/CSA C22.2 No.4-latest edition, Enclosed Switches.

.2 CSA C22.2 No.39-latest edition, Fuseholder Assemblies.

1.3 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Fusible, non-fusible, horsepower rated disconnect switch in CSA Enclosure type 2 or as indicated.

.2 Provision for padlocking in off switch position by three locks.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Fuses: size as indicated.

.5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.

.6 Quick-make, quick-break action.

.7 ON-OFF switch position indication on switch enclosure cover.

.8 Provide auxiliary Form-C contacts on switch operating mechanism where noted in drawings.

.9 Provide mechanical key interlocking scheme were noted in drawings.

.10 Exterior mounted disconnect switches shall be NEMA 4X rated.

.11 Greenhouse mounted disconnect switches shall be NEMA 4X rated.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.14-latest edition, Industrial Control Equipment.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 CONTACTORS

.1 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.

.2 Breaker or Fused switch combination contactor as indicated.

.3 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.4 Mount in CSA Enclosure type 2 unless otherwise indicated.

.5 Include following options in cover:

.1 Red indicating lamp.

.2 Stop-Start pushbutton.

.3 Hand-Off-Auto selector switch.

.4 On-Off selector switch.

.6 Control transformer: in accordance with Section 26 29 03 - Control Devices, in contactor enclosure.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

.1 Install contactors and connect auxiliary control devices.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 National Electrical Manufacturers Association (NEMA)

.1 NEMA ICS 1-2000(R2008), Industrial Control and Systems: General Requirements.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

.3 Shop Drawings:

.1 Include schematic, wiring, interconnection diagrams.

.2 Include all propose programming, modifications or software packages.

.3 Provide Riser Diagrams showing interface of all new and existing equipment as well as intermediate wiring, wiring devices, signal conditioners and measuring devices.

.4 Provide propose transition scheme with regards to field panels, devices, PLCs, RID and interface to new PSS from existing controls scheme. Propose a chronological work flow showing proposed time frames, scope of work and expected outcome as well as fail safe actions if required due to unexpected circumstances.

1.3 QUALITY ASSURANCE

.1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect control devices from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 AC CONTROL RELAYS

.1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.

.2 Fixed contact plug-in type: heavy duty 2,3 or 4 poles. Coil rating: 120 VAC or 120VDC as noted. Contact rating: 120V, 3A.

.3 Relays to include indicator LED and tab for manually actuating the relay.

2.2 RELAY ACCESSORIES

.1 Plug in relay bases with vibration clips.

2.3 PUSHBUTTONS

.1 Illuminated and/or Heavy duty. Operator extend type, as indicated, color as noted with 1-NO and 1-NC contacts rated at 120 V, 10 A, AC labels as indicated. Stop pushbuttons coloured red, provision for padlocking in depressed position labelled "emergency stop".

2.4 SELECTOR SWITCHES

.1 Maintained or Spring return to center, positions as indicated heavy duty operators knob contact arrangement as indicated, rated 120 V, 10A, AC.

2.5 INDICATING LIGHTS

.1 Heavy duty full voltage, LED type, push-to-test, lens colour: indicated], supply voltage: 120V AC/DC, lamp voltage: 120V AC/DC, labels as indicated.

2.6 CONTROL AND RELAY PANELS

.1 CSA Type 1 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.7 CONTROL CIRCUIT TRANSFORMERS

.1 Single phase, dry type.

.2 Primary: as noted, 60 Hz ac.

.3 Secondary: 120 V, AC.

.4 Rating: 250VA.

.5 Secondary fuse: amps as required.

Part 3 Execution

3.1 EXAMINATION

.1 Contractor is required to carefully review all documents provided.

3.2 INSTALLATION

.1 Replace existing control devices and equipment as noted in drawings. At completion of project, all redudant cabling and wiring shall be removed. Contractor shall demolish and remove all conduits made redundant during this project, unless specifically noted to remain by Departmental Representative.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

.5 Coordinate all commissioning and demonstration operations with Departmental Representative.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section describes manual and magnetic motor starters for motors up to 600 volts

1.2 REFERENCES

.1 International Electrotechnical Commission (IEC)

.1 IEC 947-4-1-latest edition, Part 4: Contactors and motor-starters.

.2 CAN/CSA – C22.2 No.14-latest edition, Industrial Control Equipment.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate:

.1 Mounting method and dimensions.

.2 Starter size and type.

.3 Layout of identified internal and front panel components.

.4 Enclosure types.

.5 Wiring diagram for each type of starter.

.6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 26 05 00 – Common Work Results - Electrical.

.2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

.1 Provide listed spare parts for each different size and type of starter:

.1 [1] operating coil.

.2 [2] fuses.

Part 2 Products

2.1 FULL VOLTAGE MAGNETIC STARTERS

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location.

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include circuit breaker with operating lever on outside of enclosure to control circuit breaker, and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 Selector switches: heavy duty, oil tight, labelled as indicated.

.2 Indicating lights: heavy duty, oil tight, type and color as indicated.

.3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.2 FULL VOLTAGE REVERSING MAGNETIC STARTERS

.1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Two - 3 pole magnetic contactors mounted on common base.

.2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.

.3 Three overload relays with heater elements, manual reset.

.2 Accessories:

.1 Selector switches: heavy duty, oil tight, labelled as indicated.

.2 Indicating lights: heavy duty, oil tight, type and color as indicated.

.3 Auxiliary control devices as indicated.

2.3 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.4 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results - Electrical.

2.5 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

.1 Install starters, connect power and control as indicated.

.2 Ensure correct fuses and overload devices elements installed.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and manufacturer's instructions.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

.5 Verify actual operating current with that of name plate, shop drawings and ensure correct overload selection.

END OF SECTION

Part 1 General

1.1 SCOPE OF WORK

.1 Replace all existing exit signs with new as noted in these drawings.

.2 Install new exit signs as noted in drawings.

.3 New fixtures shall be of the same configuration as the existing units with similar orientation using CSA indicated green 'running man' signage.

1.2 PRODUCT DATA

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

.2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.

Part 2 Products

2.1 EXIT SIGN TYPES

.1 White polycarbonate housing with faceplate, LED type, connect to life safety emergency power supply. Connect to existing 120V life safety emergency power supply. Replace existing exit signs.

.2 All exit signs shall comply with CSA 22.2 No.141

.3 Exit signs shall be complete with 10 year warranty.

2.2 MOUNTING TYPE

.1 Exit signs to be suitable for universal mounting. Allow for exit signs to be mounted as to best suit ceiling/wall type and architectural features:

- .1 Surface wall mounted
- .2 End wall mounted double face
- .3 Recessed wall mounted
- .4 Ceiling mounted single face
- .5 Ceiling mounted double face

.2 Exit signs to have direction arrows as indicated in drawings.

.3 Provide steel rod pendant supports for exit signs to mount to +3.5m A.F.F. in high ceiling areas as required.

Part 3 Execution

3.1 INSTALLATION

.1 Install exit signs as shown on plans complete with double face units where indicated.

.2 Connect to life safety emergency power circuit as indicated on the plans.

.3 Exit signs must be clear of all visual obstruction.

.4 Contractor to confirm locations before final installation.

3.2 MOUNTING HEIGHT

.1 Ceiling mounted signs shall be mounted directly on ceiling, unless it is obstructed from view. Stem mount using two fixture rods (9.5mm white smooth type).

3.3 SPARE

.1 Provide quantity of six (6) spare exit signs to hand over the Departmental Representative.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This section specifies materials and installation for fire detection and fire alarm systems.

1.2 REFERENCES

.1 NBC-latest edition, National Building Code of Canada.

.2 Government of Canada

.1 TB OSH Chapter 3-03, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-03, Standard for Fire Protection Electronic Data Processing Equipment.

.2 TB OSH Chapter 3-04, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.

.3 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S524-latest edition, Installation of Fire Alarm Systems.

.2 ULC-S525- latest edition, Audible Signal Appliances.

.3 CAN/ULC-S526- latest edition, Visual Signal Appliances, Fire Alarm.

.4 CAN/ULC-S527- latest edition, Control Units.

.5 CAN/ULC-S528- latest edition, Manual Pull Stations.

.6 CAN/ULC-S536- latest edition, Inspection and Testing of Fire Alarm Systems.

.7 CAN/ULC-S537- latest edition, Verification of Fire Alarm Systems.

1.3 DESCRIPTION OF EXISTING SYSTEM

.1 The existing fire alarm system in an Edwards EST1, single zone conventional fire alarm system that ties back into the main building fire alarm system. New devices are to be fully compatible with the existing system and shall tie into this existing system.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

.1 System:

.1 To TB OSH Chapter 3-04.

.2 Subject to Fire Commissioner of Canada (FC) approval.

.3 Subject to FC inspection for final acceptance.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include:

.1 Layout of equipment.

.2 Complete wiring diagram, including schematics of modules.

1.6 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual.

.2 Include:

.1 Technical data - illustrated parts lists with parts catalogue numbers.

.2 Copy of approved shop drawings.

.3 List of recommended spare parts for system.

1.7 EXTRA MATERIALS

.1 Provide maintenance materials as recommended by the system manufacturer. Submit recommended spare parts list to Consultant for review in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include four (4) spare glass rods for manual pull box stations if applicable.

1.8 MAINTENANCE

.1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Departmental Representative.

Part 2 Products

2.1 MATERIALS

.1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.

.2 In accordance with applicable CAN/ULC standards.

.3 Single stage operation: operation to actuation following:

.1 Manual station.

.2 Heat detector.

.3 Smoke detector.

.4 Automatic fire sprinkler system.

2.2 MANUAL ALARM STATIONS

.1 Manual alarm pull stations: conventional, pull lever, wall mounted surface type, with English and French signage.

.2 Key switch for reset.

.3 Manufacturer - Manual pull station: Edwards.

2.3 WIRE AND CABLE

.1 Conductor Insulation: Minimum rating 300 volts. Single conductor RW90XLPE (X-link).

.2 Multi-conductor cables 105°C with outer PVC jacket, colour coded, FAS rated.

.3 Conductor sizes as follows:

.1 To initiating circuits: #18 AWG minimum, and in accordance with manufacturer's requirements.

.2 To signal circuits: #16 AWG minimum, and in accordance with manufacturer's requirements.

.3 To control circuits: #12 AWG minimum, and in accordance with manufacturer's requirements.

.4 Size all fire alarm wiring for maximum 3% voltage drop at maximum load at last device in run.

.4 All wiring to be copper.

.5 All wiring to be tag identified at the points of connection.

.6 Provide a ground conductor with all system wiring and bond all metal parts including device boxes.

.7 All fire alarm system wiring to be in conduit except short drops from ceiling junction box to detectors mounted in T-Bar ceiling may be rated fire alarm system cable.

2.4 AS-BUILT RISER DIAGRAM

.1 Fire alarm system riser diagram: in glazed frame minimum size 600 x 600 mm.

Part 3 Execution

3.1 INSTALLATION

.1 Install systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-04.

.2 Connect new alarm devices to existing Class B zone wiring. Connect to nearest device as noted in drawings.

3.2 FIELD QUALITY CONTROL

.1 Perform tests as described herein and in accordance CAN/ULC-S537.

.2 Fire alarm system:

.1 Check annunciator panels to ensure zones are shown correctly.

.2 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.

.3 Manufacturer’s technician to verify all new devices and reconnected existing fire alarm system equipment and components in accordance with ULC Standard S537.

.4 Provide a Certification of Verification.

.5 After verification, demonstrate and spot test system as required by Consultant and Fire Commissioner.

.6 Provide Engineer with written verification report for review and include copies in maintenance manuals

END OF SECTION

Appendix A

Certificate of Exemption of Contractor

BRITISH COLUMBIA | Ministry of Finance

CERTIFICATE OF EXEMPTION
CONTRACTOR

under the *Provincial Sales Tax Act*

Responsibilities for Sellers and Eligible Contractors:

Sellers – this certificate allows you to collect the information and declaration required under the *Provincial Sales Tax Act* (the Act) in order to provide a PST exemption to your customer.

If you do not receive a completed and signed certificate or the required information and declaration before the sale, you must charge and collect PST. Failure to do so may result in an assessment, penalty and interest.

Eligible Contractors – you are responsible for ensuring that you meet all the requirements for the exemption under the Act. If you complete the certificate but you do not qualify for the exemption, you are responsible for paying the PST.

General Instructions:

- Refer to **Page 2** for detailed instructions.

Freedom of Information and Protection of Privacy Act (FOIPPA)
The personal information on this form is collected for the purpose of administering the *Provincial Sales Tax Act* under the authority of both this Act and section 26 of the FOIPPA. Questions about the collection or use of this information can be directed to the Manager, Program Services, PO Box 9442 Stn Prov Govt, Victoria, BC V8W 9V4. (Telephone: toll-free at 1 877 388-4440)

PART A – CERTIFICATION OF ELIGIBLE PERSON (*see Page 2*)

NAME OF CORPORATION, ASSOCIATION, PARTNERS, INDIAN BAND OR INDIVIDUAL	MAILING ADDRESS (*including postal code*)

I certify that I have entered into a contract with the eligible contractor named below for the supply and installation of affixed machinery or improvements to real property and if I were to purchase the tangible personal property identified below I would be exempt from PST because (*check (✓) one and complete the appropriate section*):

1. ☐ I am eligible for the **Production Machinery and Equipment** (PM&E) exemption under the Act.

2. ☐ I am a **status Indian** or authorized representative of an Indian band and the items being purchased would be exempt from PST under section 87 of the *Indian Act* (Canada). If you are representating an Indian band, attach written authorization from an official of the band that you are authorized to act on behalf of the Indian band.

	BAND NAME	STATUS CARD NUMBER
Indian and Indian Bands		
Indian Bands Only	NAME OF REPRESENTATIVE	

3. ☐ I am a **qualifying aquaculturist** under the Act. — AQUACULTURE LICENCE NUMBER

4. ☐ I am a **qualifying farmer** under the Act. — PROPERTY TAX FOLIO NUMBER / ADDRESS OF FARM

5. ☐ I am eligible for a PST exemption under the **Consular Tax Exemption Regulation.** — DIPLOMATIC / CONSULAR IDENTITY CARD NUMBER | EXPIRY DATE YYYY / MM / DD

I certify that the Government of Canada has entered into a contract with the eligible contractor named below for the supply and installation of affixed machinery or improvements to real property.

6. ☑ I am an **authorized representative of the Government of Canada.** — PST NUMBER: PST-1000-5001

By signing this form, I certify that the above information is correct.

FULL LEGAL NAME OF INDIVIDUAL SIGNING FORM	SIGNATURE	DATE SIGNED YYYY / MM / DD
Patrick Truong	X	2016/06/01

PART B – CERTIFICATION OF ELIGIBLE CONTRACTOR (*see Page 2*)

FULL LEGAL NAME	MAILING ADDRESS (*including postal code*)

Description of all items of tangible personal property (goods) being purchased (*if you require more space, attach an additional document*):

I certify that the tangible personal property (TPP) identified above is being acquired to fulfill a contract for the supply and installation of affixed machinery or improvements to real property that meets the requirements of (*check (✓) one*):

7. ☐ **Customer is the eligible person identified in Part A:** the contract is with the eligible person identified in Part A, or — ELIGIBLE CONTRACTOR'S PST NUMBER

8. ☐ **Customer pays the PST:** you have a written agreement with your customer that they will pay PST on the TPP described above and the agreement sets out the purchase price of the TPP. You must be registered for PST before supplying this TPP to your customer. You may only use this certificate in advance of receiving your PST number.

By signing this form, I certify to the best of my knowledge that the above information and any attached information is correct. I acknowledge that if I make a false statement to avoid paying tax, the *Provincial Sales Tax Act* charges a fine of up to $10,000 and/or imprisonment up to two years, in addition to a penalty of 25% of the tax due and an assessment for the tax that should have been paid.

FULL LEGAL NAME OF INDIVIDUAL SIGNING FORM	SIGNATURE	DATE SIGNED YYYY / MM / DD
	X	

CERTIFICATE OF EXEMPTION – CONTRACTOR

For more information on this certificate or other certificates of exemption, visit our website at gov.bc.ca/pst or call us toll-free at 1 877 388-4440.

INSTRUCTIONS:

PART A – To be completed by the eligible person, as described below, only if the contract for the supply and installation of improvements to real property is with an eligible person.
PART B – To be completed by the eligible contractor. Note: If a contractor is claiming an exemption based on Box 8, this certificate may only be used where the contractor does not have a PST number.
ELIGIBLE CONTRACTOR – Have your customer complete Part A if they are an eligible person and provide the seller with the original copy of this certificate.
SELLER – Keep the completed certificate to show why you did not collect PST on the sale.
USING THIS CERTIFICATE FOR FUTURE SALES – The use of this certificate for future sales is restricted to purchases related to a specific contract with an eligible person. Contractors who are purchasing exempt, as described in Box 8, cannot use the certificate for any other tangible personal property (TPP) than the specifically listed TPP (the TPP that the customer has agreed to pay PST on).

ELIGIBLE PERSONS:

The following are descriptions of the eligible persons listed in Part A:

1. Persons eligible for exemption under *Provincial Sales Tax Act* (the Act) include **manufacturers, oil and gas producers and exploration companies, mine operators and exploration companies, local governments and local government corporations, loggers and service providers**. For exemption qualifications, refer to **Bulletin PST 110**, *Production Machinery and Equipment Exemption*.
2. A **status Indian** is a person who qualifies as an "Indian" under the *Indian Act* (Canada) and who is in possession of a *Certificate of Indian Status* card issued by the federal government. For exemption qualifications, refer to **Bulletin PST 314**, *Exemptions for First Nations*.
3. A **qualifying aquaculturist** is defined under the Act. An aquaculture licence is a licence issued under the *Fisheries Act* (British Columbia) or the Pacific Aquaculture Regulations made under the *Fisheries Act* (Canada). For exemption qualifications, refer to **Bulletin PST 103**, *Aquaculturists*.
4. A **qualifying farmer** is defined under the Act. For exemption qualifications, refer to **Bulletin PST 101**, *Farmers*.
5. Persons eligible for exemption under the **Consular Tax Exemption Regulation** include qualifying diplomatic agents, senior officials of United Nations' agencies situated in Canada, career consular officers, administrative and support staff of consular posts, and spouses of persons referred to above. For exemption qualifications, refer to **Bulletin CTB 007**, *Exemption for Members of the Diplomatic and Consular Corps.*
6. **Authorized representative of the Government of Canada:** under the Act, a contractor is exempt from PST on goods used to fulfill a written contract with the Government of Canada for the supply and installation of real property, such that the goods cease to be personal property at common law.

Appendix B

Sequence of Operation of Controls

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ENVIRONMENTAL TEMPERATURE
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PACIFIC FOREST RESEARCH CENTRE

Victoria, B.C.

PHASE 2B

SEQUENCE OF OPERATION

of

CONTROLS

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GLASSHOUSE HEATING

The primary heating loop program maintains a 10°C. water temperature, (sensor 108) above the compartment demanding the highest water temperature. This program is capable of operating dual circulating pumps, (P10 and P11) on an alternate daily basis and demand basis. The program controls the heat exchanger by modulating the steam control valve, CV28, (205) and the stand-by electric side arm heater, by modulating the five stages of electric heat.

In the production and research compartment heating, the low level program controls its respective mixing valve, CV7 to CV15, (203) and cycles the secondary circulating pumps, P1 to P9, to deliver a water temperature based upon the calculation derived from the room temperature (106), outside temperature (105), light intensity (104), and wind speed (103). The calculated water temperature controls the on/off function of the circulatory pump. The program has time delay, second night program, and light dependent increases. The high level heating elements will be controlled as an off/on function, based on the calculated water temperature of the low level system, by opening/closing its respective 2-Way control valves, CV1 to CV6, and CV16 to CV27, (204).

In the corridor heating, a space sensor (106), will modulate control valves, CV38 and CV39, (204), to maintain the required corridor temperature.

GLASSHOUSE VENTILATION CONTROL

The ventilation program modulates leeward and windward vents, turns on/off destratification fans, open/close side vents, and, brings on four stages of evaporative coolers, based on; inside temperature and humidity (106), light intensity (104), rain (101), wind direction (102), wind velocity (103), and outside temperature (105). This program also shows which position the vents are in, through the vent position indicators (107). The shading program will influence computer decision on ventilation and this program is completely interfaced with the heating program .

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GLASSHOUSE HUMIDITY CONTROL

The humidity control is achieved through ventilation and heating, with an operator set bias. The misting humidity control modulates control valves CV29 to CV37 (402), in the misting system piping.

GLASSHOUSE PRODUCT and RESEARCH DEPARTMENT LIGHT MONITORING CONTROL

The lighting program controls photo period lighting in each compartment, except, the one small research compartment, where it controls high intensity light in two stages.

There is a light meter connection (109), in each compartment, for, individual light measurements. One portable Kipps Solarmeter (110), is supplied for these connections.

GLASSHOUSE SCREEN CONTROL

The computer will control shading curtains in all compartments, plus, a blackout curtain in the production area. Also, this program can be used as an energy rentention system, and, completely interfaces with all other programs.

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GLASSHOUSE GRAPHICS

Twenty-five channels of graphics will record data from any measurement available to the computer, over an adjustable period of up to ninety-nine hours. Also, program will numerically record the high and low temperature of each graph.

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GLASSHOUSE ALARM

The operator will set the high and low limits from the calculated set point. When an alarm is activated, the signal is sent by telephone to the home of the greenhouse manager. Alarm is activated by:

1. Calculated set point out of reach.
2. Air temperature too low.
3. Air temperature too high.
4. Water temperature does not rise when valve opens.
5. Vent motor does not respond when activated.
6. Irrigation valve does not open or stays open.
7. EC too high or too low.
8. PH too high or too low.
9. Wet bulb wick has dried out.
10. Incorrect input of set points by operator.
11. Alteration in memory (internal).
12. Power down.

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GLASSHOUSE CONTROL COMPUTER

The computer has the capability of having irrigation and feeding programs added to it in the future. Both PH and EC will be controlled and monitored in relation to sunlight and light intensity.

The computer control system is a central dedicated controller to monitor, control and record the functions of each glasshouse environment separately. It is located adjacent to the glasshouse complex in a stable, dust free computer room and out of direct sunlight. All input/output and recording of data is achieved in this office.

The computer is equipped with a V.D.U. and simple keyboard terminal for easy access/input of data. It has a graphic printer for 'hardcopy' recording of reports, measurements and alarms. The printer is capable of displaying every function for each environment separately with 'set point', 'calculated value'. In addition it can, where necessary, indicate the average values with the highest and lowest values measured. Switching times for day/night and night/day settings are on an astronomical basis.

Reports on hard copy are generated on a time interval selected by the operator and/or upon demand. Reports will be concise and indicate outside climatic conditions, namely:

1. Outside air temperature.
2. Light level in K. lux.
3. Wind direction.
4. Wind velocity in m/sec.
5. Precipitation.

Inside conditions will be reported from each house separately and sequentially. For each environment it will read.

1. Measured values and calculated values for heating.
2. Mixing value and calculated value for water temperature.

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con't.

3. Mixing value and calculated value for ventilation and humidity.
4. Also, giving the average values and high and low measurements where desired.

Reports in the form of graphics will be possible with the individual channels to be selected by the operator.

The computer will be able to control ten separate glasshouse environments and have the potential for expansion to a maximum of twenty-five environments. The construction of the computer will allow an 'up-date' of all programs and if necessary the addition of new programs such as $C0^2$ and irrigation capability. The programming will be in machine language. In this way it will be possible to keep the original computer on the same technical level as the most 'up to date' models in subsequent years.

For heating it will be possible to set a maximum and minimum water temperature both for day and for the night periods. The daytime water temperatures will be light dependent i.e. as the light levels increase so the water temperature is decreased on a linear scale. The degree and range of this function to be set by the operator. As daytime temperqtures rise above 'set point' it will be possible to turn off the circulation pump automatically.

The air temperature set point will be light dependent i.e. to raise the set point on a linear scale dependent upon measured light levels. All limits and scale to be set by operator. Day and night 'set points' will be set into the computer. The switch over times to be adjusted astronomically i.e. approximately two minutes change per twenty-four hours automatically. It will be possible to dictate the number of minutes it takes to change per degree up and down i.e. 4° C. difference between day/night set point with gradient of thirty minutes per degree on linear scale.

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The heating set point and control will also respond to outside air temperature and wind velocity and be compensated for this cooling factor automatically. The control will anticipate reduced heat load based on rising outside air temperature and conversely anticipate increased heat load on falling outside temperatures. It will also be possible to initiate a 'heat boost', i.e. increase the water temperature above calculated demand. This will be initiated if the humidity rises too high or remains at slightly above set point for too long.

Ventilation temperature will be light dependent. Day and night 'set points' will be set into the computer. The switch over times again will be adjusted astronomically. Again a time per degree rise and fall for switching times will be possible. Ventilation will be controlled on the basis of inside air temperature and/or humidity. A humidity day and night set point will be possible. Control and ventilation of humidity will be influenced by outside air temperature and degree of rise above set point ventilation will be ahcieved by modulating a roof vent motor.

The roof vents will be influenced also by wind velocity and outside air temperature. It will be also possible to restrict vent openings and movement based on the degree of precipitation, wind speed and direction. Where the vents are either side of the ridge it will be possible to always open to the 'leeward' vent first. Sensors for air temperature and humidity will use wet and dry bulb measurement in an aspirated screen. If the inside air temperature rises a pre-set amount above ventilation set point when the vents are fully open the computer will initiate and control the coolers to bring the air temperature back to set point. The computer will be able to read and record both calculated and measured air temperature and humidity. It will also record the vent position in the % open.

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HEADER HOUSE PRIMARY HEATING LOOP CONTROL

An outside sensor (601), will modulate a steam control valve (605 and 606), CV49, in the pipe connection to the steam to hot water convertor. The primary loop water temperature is scheduled based on the outdoor air temperature.

When the outdoor air temperature exceeds 18.5° C. (609), the primary loop pump will stop. A time-clock (608), will control the operation of the primary circulating pump.

A night set back thermostat (612), located in the staff room, will override the timeclock to cycle the primary loop circulating pump, to maintain a space temperature of 13° C.. Also, when the circulating pump is off, the steam control valve, CV49 (605 and 606), will close.

HEADER HOUSE TERMINAL HEATING CONTROL

An electric wall mounted thermostat (701), will position a two-way electric control valve (702), in the radiation piping, to maintain required required room temperature.

UNIT HEATER CONTROL

An electric wall mounted thermostat (703), will cycle its respective unit heater and modulate a three-way control valve (704), to maintain the required room temperature.

MECHANICAL ROOM and ELECTRICAL ROOM VENTILATION CONTROL

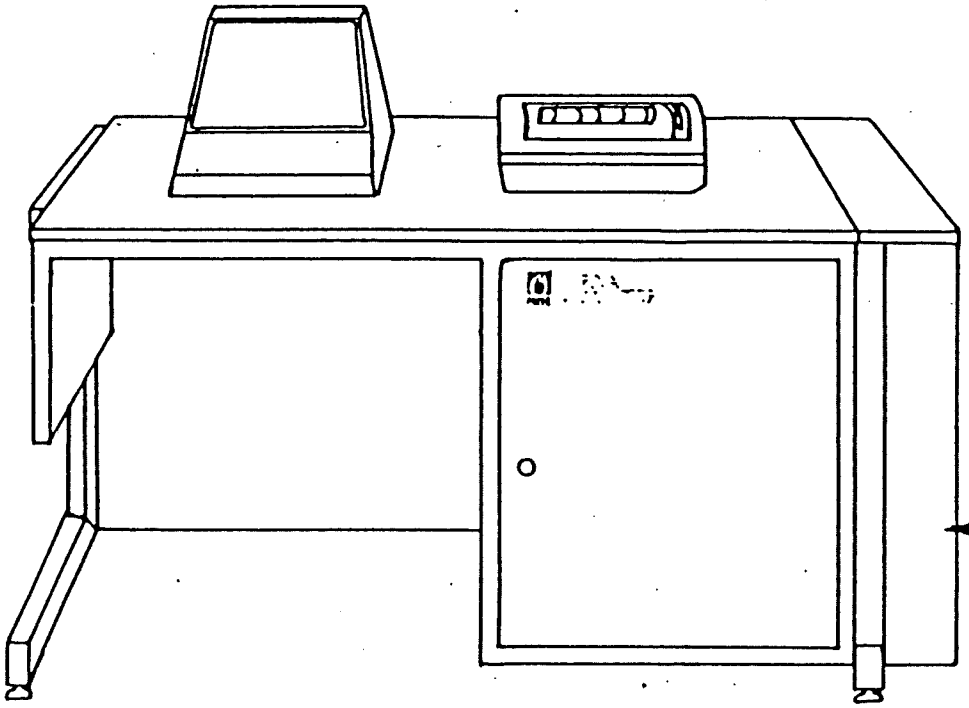
A line voltage wall mounted thermostat (705), will cycle the wall fan to maintain required room temperature.

PRIVA COMPUTERS

INSTALLATION INSTRUCTIONS

FOR THE

PRIVA UNIVERSAL COMPUTER



JUNCTION BOX FOR
EXTERNAL CABLES
fig. -1-

DIRECTION FOR POSITIONING AND INSTALLING EXTERNAL SENSORS

The sensors which measure the outside conditions can generally be mounted together o[n a] single mast (see fig -3-), which protrudes about 6 feet above the roof of [the] shed or greenhouse.
All sensors must be placed so that they are not influenced by obstructions in the immediate vicinity such as trees,chimneys, buildings, etc., otherwise they may give incorrect measurements and indications.
When the external sensors are mounted on one mast it is desirable to run the connecting leads from the sensors to a junct on box installed in the shed or building on which the mast is placed. From there the sensors can be connected by two separate multi-leadcables (one for the rain detector and one for the other sensor) to the computer (connection board 9930) (see also connection diagram fig -16-).

Light sensor

The light sensor must be positioned in such a way that obstructions such as chimneys, trees or other outside sensors cannoot cast a shadow on it between sunrise and sunset. The light sensor is connected by 4 leadsof the cable to connection board (terminal B nos. 1-2-3-4).

Outside temperature sensor

The ouside temperature sensor must not be positioned too close to heat ources such as chimneys, roofs, etc. The outside temperature sensor is connected by 2 leads of the cable to connection board 9930 (terminal B nos. 9-10).

Wind velocity sensor

This must be placed so that it is not in the lee of buildings or other obstructions.The wind speed sensor is connected by 2 leads to connection board 9930 in the computer (teminal B nos 7-8).

[Wind] direction sensor

must be positioned in such a way that the wind reaching it has not been deflected by buildings, etc. The wind direction sensor is connected by 2 leads to connection board 9930 (terminal B nos. 5-6).

Adjustment of wind direction sensor

The wind direction sensor is adjusted as follows. Turn the sensor so that when the wind-vane points towards " north " a resistance of 1 k ohm is measured between the connection wires.
Because the wind direction sensor determines which vents are on the lee side and which are on the wind side, the following points must be borne in mind when connecting the windows:

1. The most northerly facing vents are connected as vents 1.
2. If the roof-ridge of the greenhouse runs north-south, the most westerly facing vents are connected as vents 1.

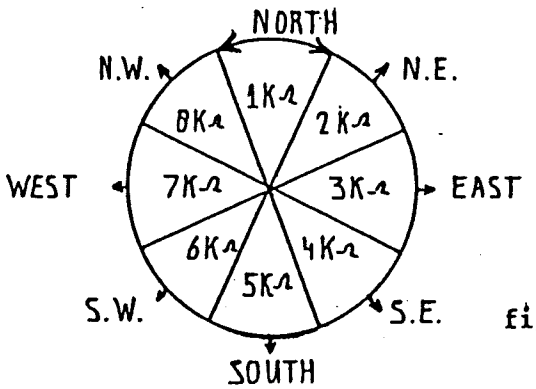


fig -2-

Rain Detector

This must also be placed clear of obstructions and not in the lee of buildings. It must be positioned well away from foot-mounted sprinklers.
The rainfall detector is connected by 7 *leads* (separate cable) to connection board 9930 (terminal B nos. 12 to 18).

Solar meter

If a solar meter is installed there is no need for a light sensor. The rules for positioning the light sensor also apply to the solar meter. In addition, care must be taken to ensure that the solar meter is horizontal (level) and stable. The solar meter is connected by 2 *leads* to the terminals on printed circuit 9943 (check polarity). Blue = + , Black = - . See fig. -17-.

When the solar meter is installed, the cable outlet must point to the North.

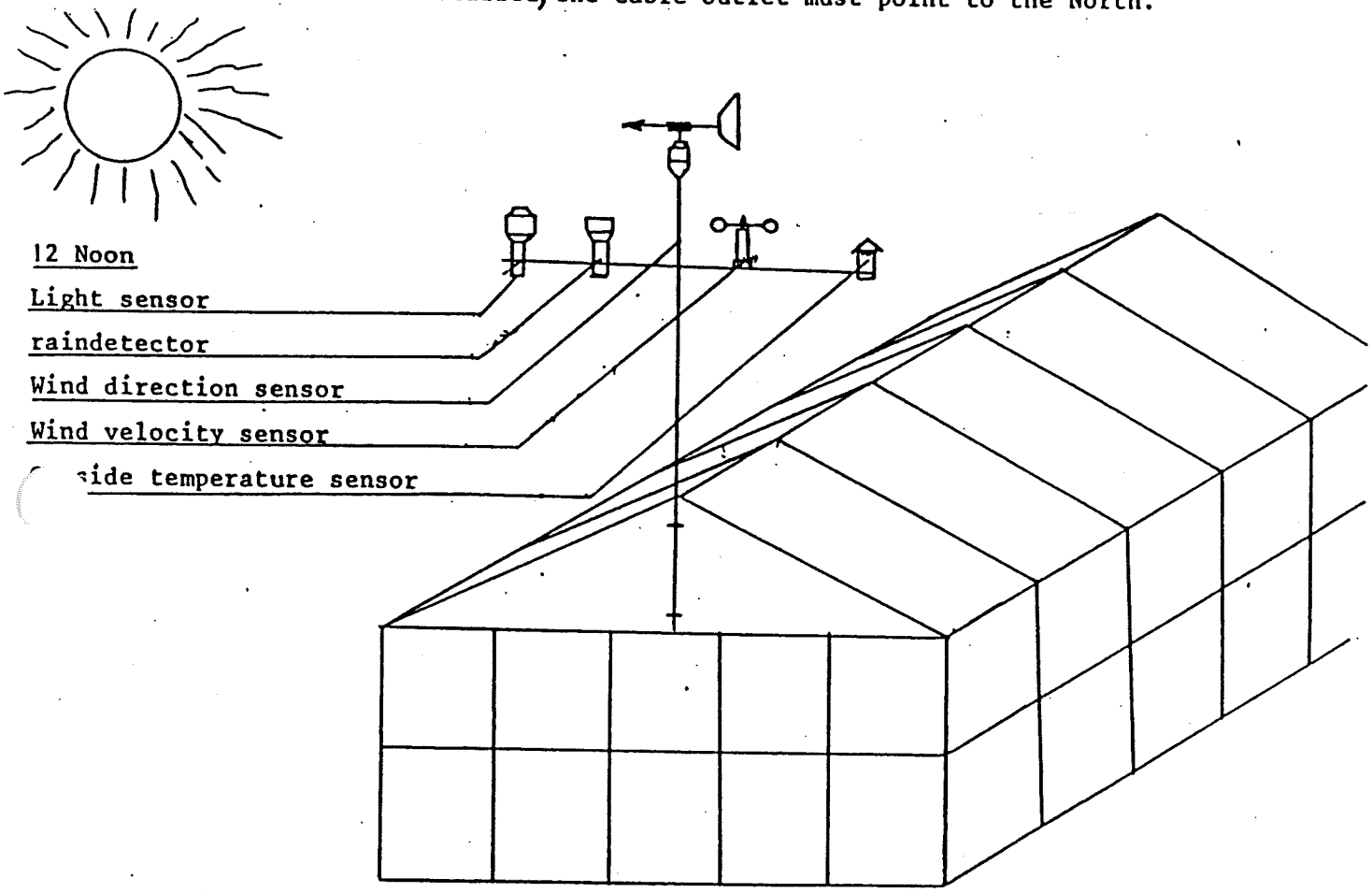
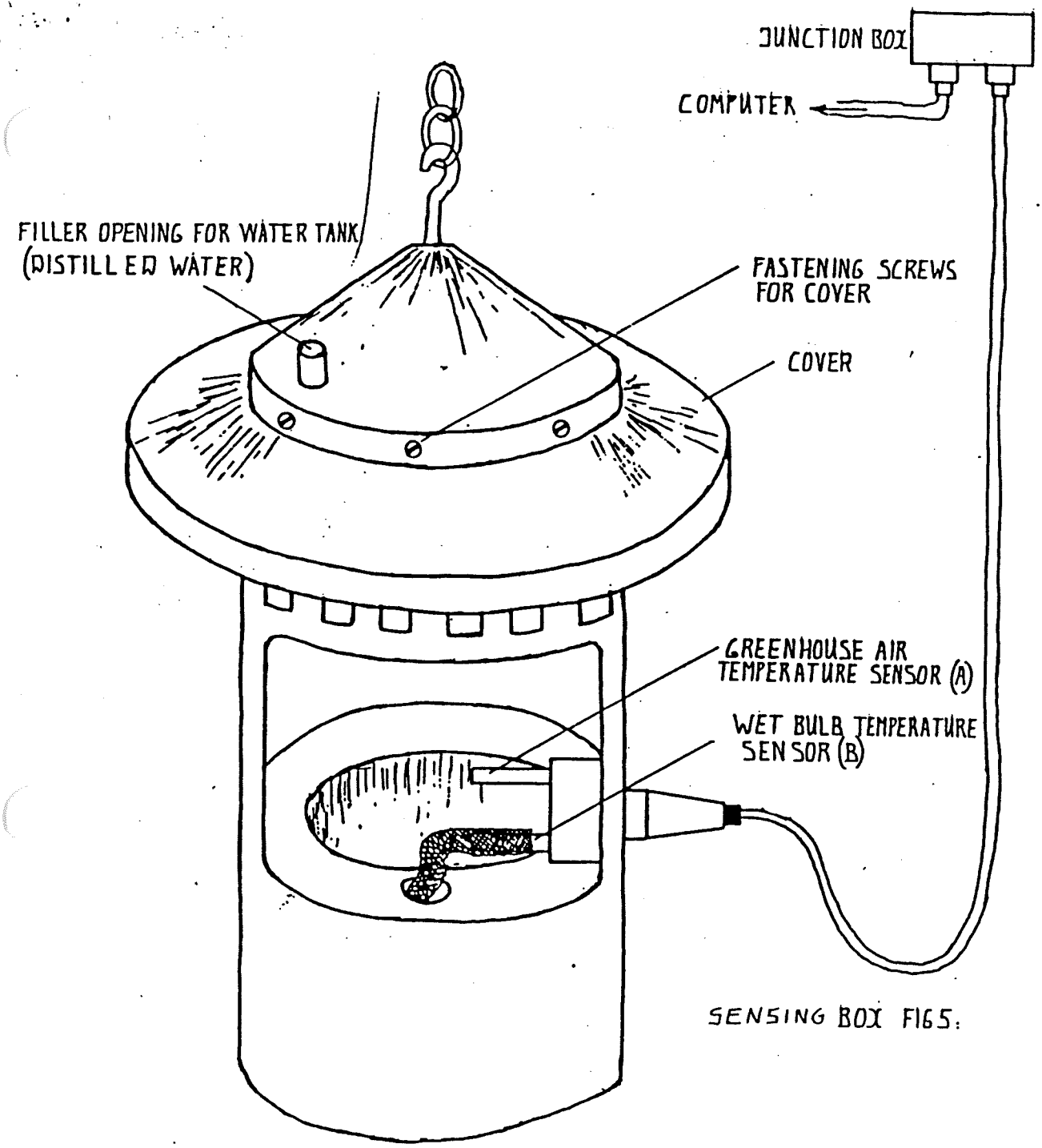


FIG: 3



SENSING BOX FIG 5.

Note: For wires connecting the temperature and wet-bulb sensors to the computer, double the number of AWG-18 leads for each 1000 feet of cable run. For the leads to the ventilation fan, double the leads for each 300 feet of run. If lead requirements for the ventilation fan become excessive, install a separate 24VAC power supply to handle one or more sensor boxes.

DIRECTIONS FOR INSTALLATION AND ASSEMBLY OF INTERNAL SENSORS

(see connection diagram fig. -18-)

Installing the sensing box

This must be suspended from the chain supplied so that the height can be adjusted. A flexible connection cord 11½ feet long with a plug is supplied with the sensingbox. One end of this cord is connected to the circuit through a junction box, the other end is attached to the sensing box by means of the connector on the box. The box cord must always hang in a loop (see fig. -4-) so that water cannot get into the connector.
The sensing box must always be placed in a position representative of the climate (temperature and humidity) in the greenhouse, i.e. the direct effects of concrete paths, heating pipes and open vents must be avoided. It must therefore not be positioned above heating pipes or under vents which open. Generally , a point halfway down the greenhouse and about 30 feet from the concrete path is a good measuring-point.
The sensing box must be accessible for inspection and for topping-up with distilled water.

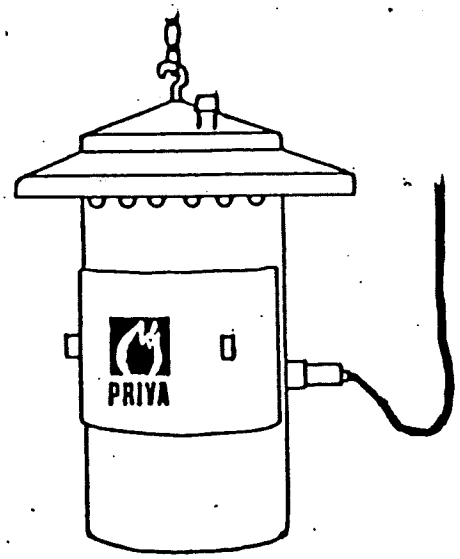


fig -4-

Specification

The sensing box contains 2 temperature sensors : A is the greenhouse air temperature sensor ; B is the wet -bulb temperatur sensor (psychrometer). The wet-bulb temperature sensor is closest to the " knee " on the water-tank and has a wick pushed over it. This wick must be wet and must pass through the knee into the water-tank. Checks should be carried out every one or two weeks on the water level and to ensure that the wick remains damp.
It is further recommended that the ventilator be lubricated with a drop of oil at least once a year. To do this the cover of the sensing box must be removed (see fig -5-).

Connecting the sensing box

The sensing box cable contains 7 leads , 6 of which are used. They are numbered and must be connected as follows:

sensing box cable	(No. 1)	
	(2)	ventilator 24 V AC
	(3)	
	(4)	wet-bulb sensor
	(5)	
	(6)	greenhouse air temperature sensor
	(yel/green)	not connected.

By installing an extra external on/off switch for the ventilator in the sensing box the ventilator can be switched off manually, for example, when dusting with pesticides, etc.
For additional information on connecting the sensing box etc. see the general connection drawing and list.

WATER TEMPERATURE SENSOR

The water temperature sensors must be mounted downstream of the mixing-valve, e. in the water which goes to the zone. The best point for mounting the water temperature sensor is about 3-6 feet downstream of the mixing-valve, where the water is well-mixed.

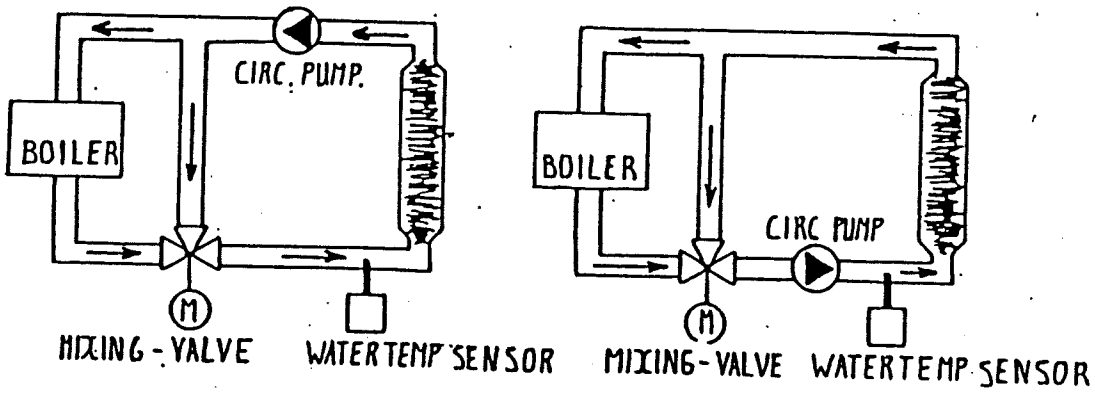
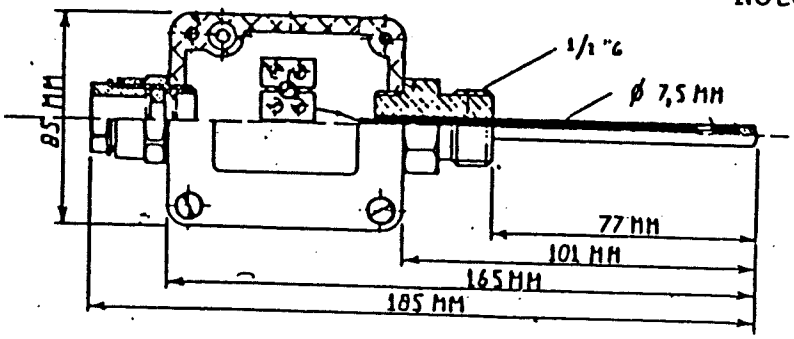


fig -6-

The water temperature sensor is connected by 2 leads. If the distance between the water temperature sensor and computer is greater than 1000', the number of leads must be doubled to prevent measurement errors.

Note: 1 inch= 25.4 mm



WATER TEMPERATURE SENSOR fig. -7

MIXING-VALVE BOX

The mixing-valve box is connected between the computer and the servomotor of the mixing-valve and must be mounted as close as possible to the mixing-valve. The mixing-valve box contains a switch which automatically controls the opening, closing and shut-off of the mixing-valve.
The standard mixing-valve box is suitable for controlling 24 VAC mixing-valve motors. A special version is available for controlling 220 V AC mixing-valve motors.

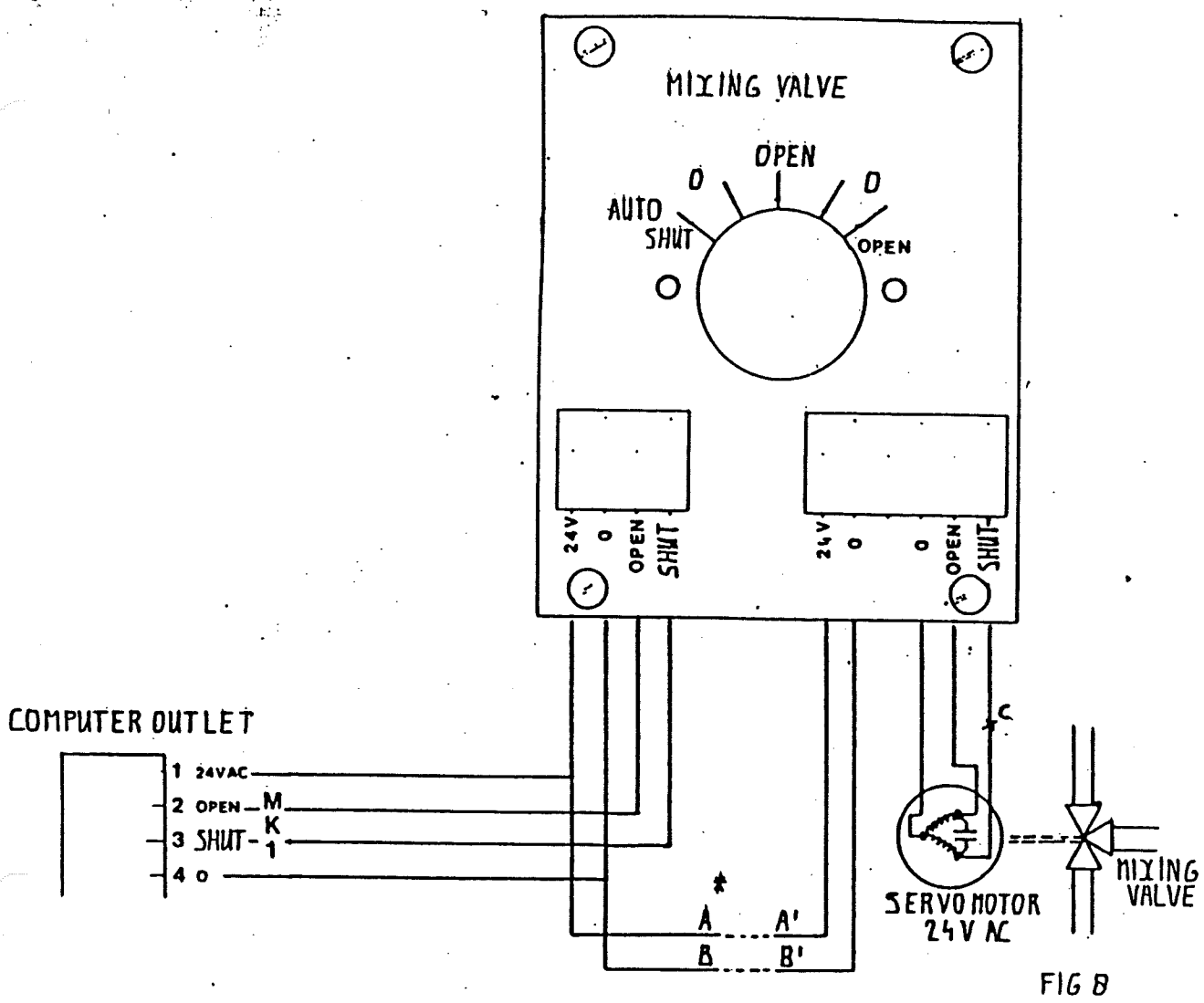
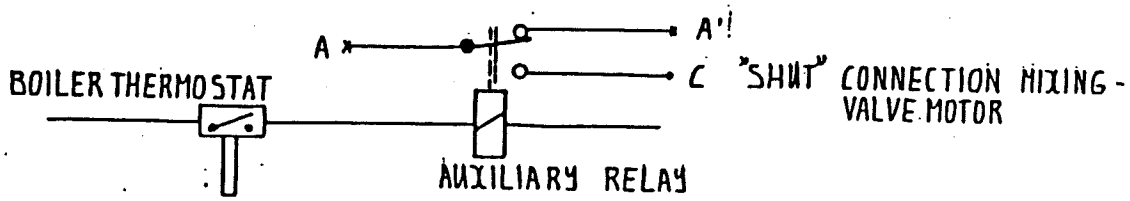


FIG 8

x Mixing-valve motor supplied from computer : connect A-A' and B-B'.
Mixing-valve motor supplied externally : connect 24 V AC to A' and B'.

If a minimum temperature boiler thermostat is used, it can be connected as shown below, so that the mixing - valve is automatically closed as soon as the temperature of the water in the boiler falls below the temperatureset on the thermostat.



4 leads are needed for connecting the mixing-valve box. If the mixing-valve motor is not supplied from the computer and the distance between mixing-valve box and computer is greater than 1000' , the number of leads must be doubled.
If the mixing-valve motor is supplied from the computer, the number of leads needed is dependent on the power (current) used by the mixing-valve motor and the consequent voltage loss in the cable.

PUMP SHUT OFF

A standard feature of the PRIVA computer is a program to automatically switch off the curculation pump of the central heating system when it is not needed and when the water temperature drops below the pre-set minimum water temperature.

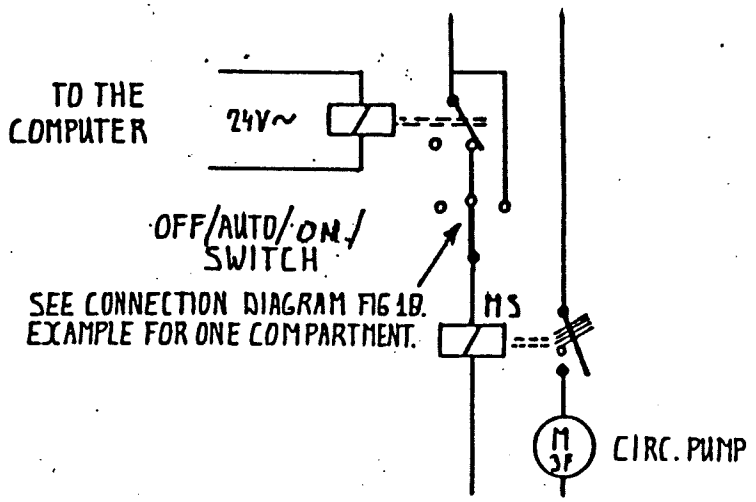


fig -10-

2 connecting wires are needed to drive the auxiliary relay. Above about the number of leads must be doubled. If the auxiliary relay is not powered——— circulation pump on.

VENT POSITION INDICATOR

The vent position indicators are used to relay the position of the vents to the computer.
Two types of vent position indicator are available :
SP 10 for use with ventopenings of 0 - 60 °C with a maximum aperture of 60°C.
S for use with vent openings of 0 - 90 °C. with a maximum aperture of 90°C
(...t to be used where the maximum aperture is less than 60°C.)

Adjustment of vent position indicators

For assembling and adjusting the vent position indicators the procedure is as follows.
Close the vent and hold the vent position indicator against the frame next to the vent with the spring fully tensed, and allow the short arm of the vent position indicator to press against the vent .
Adjust the long arm bearing. See fig - 11A -
Next, open the vent fully and move the vent position indicator, with the spring completely released , along the frame until the long arm still just touches the open vent (see fig -11C-). Mount the vent position indicator on the frame at this point.
When the vents are closed the resistance value of the response potentiometer, measured between the slide (yellow) and shut (orange), must be a minimum of 50 ohm. When the vents are fully open this resistance must be between 950 and 1000 ohm (see fig. -11C-). These resistance values are pre-set at the factory.

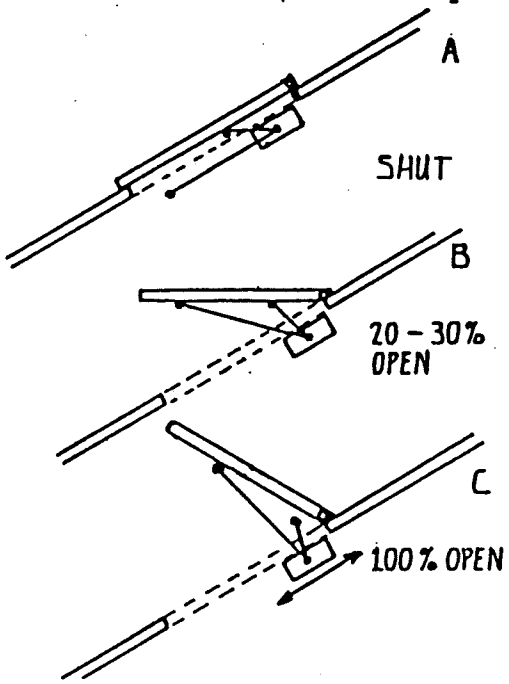


fig. -11-

The vent position indicators are connected by 3 *leads* . If the distance from the computer is greater than 1000' the number of cores must be doubled.
To determine vent 1 and vent 2 see wind direction sensor.
The computer controls the vent motors via a vent box which must be fitted with auxiliary relays (24 V AC) and connected according to the diagram below.

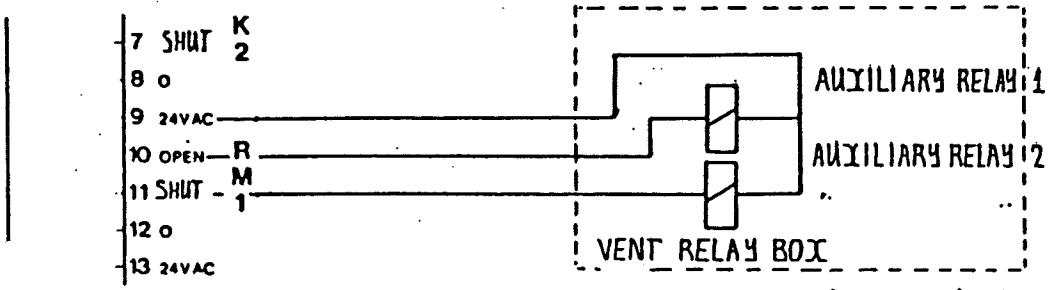
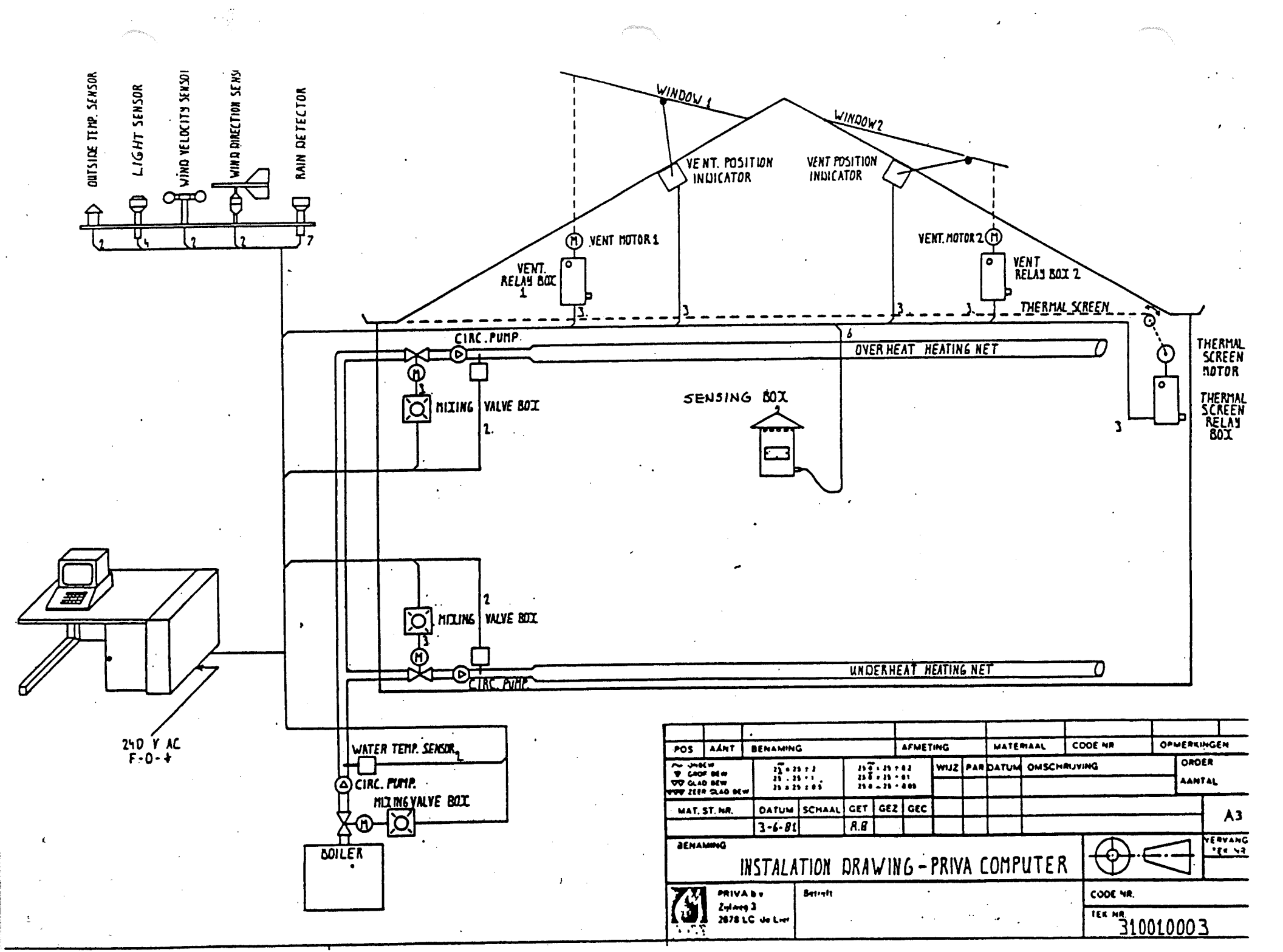


fig -12-

For a complete circuit diagram of a vent relay box with a switch for manual operation see fig -19- A vent relay box is connected with 3 *leads* and the distance to be bridged with a number of *leads* is dependent on the auxiliary relays used (current consumed).



POS	AANT	BENAMING	AFMETING	MATERIAAL	CODE NR	OPMERKINGEN

WIJZ	PAR	DATUM	OMSCHRIJVING	ORDER AANTAL

MAT. ST. NR.	DATUM	SCHAAL	GET	GEZ	GEC
	3-6-81		A.B		

A3

BENAMING

INSTALATION DRAWING - PRIVA COMPUTER

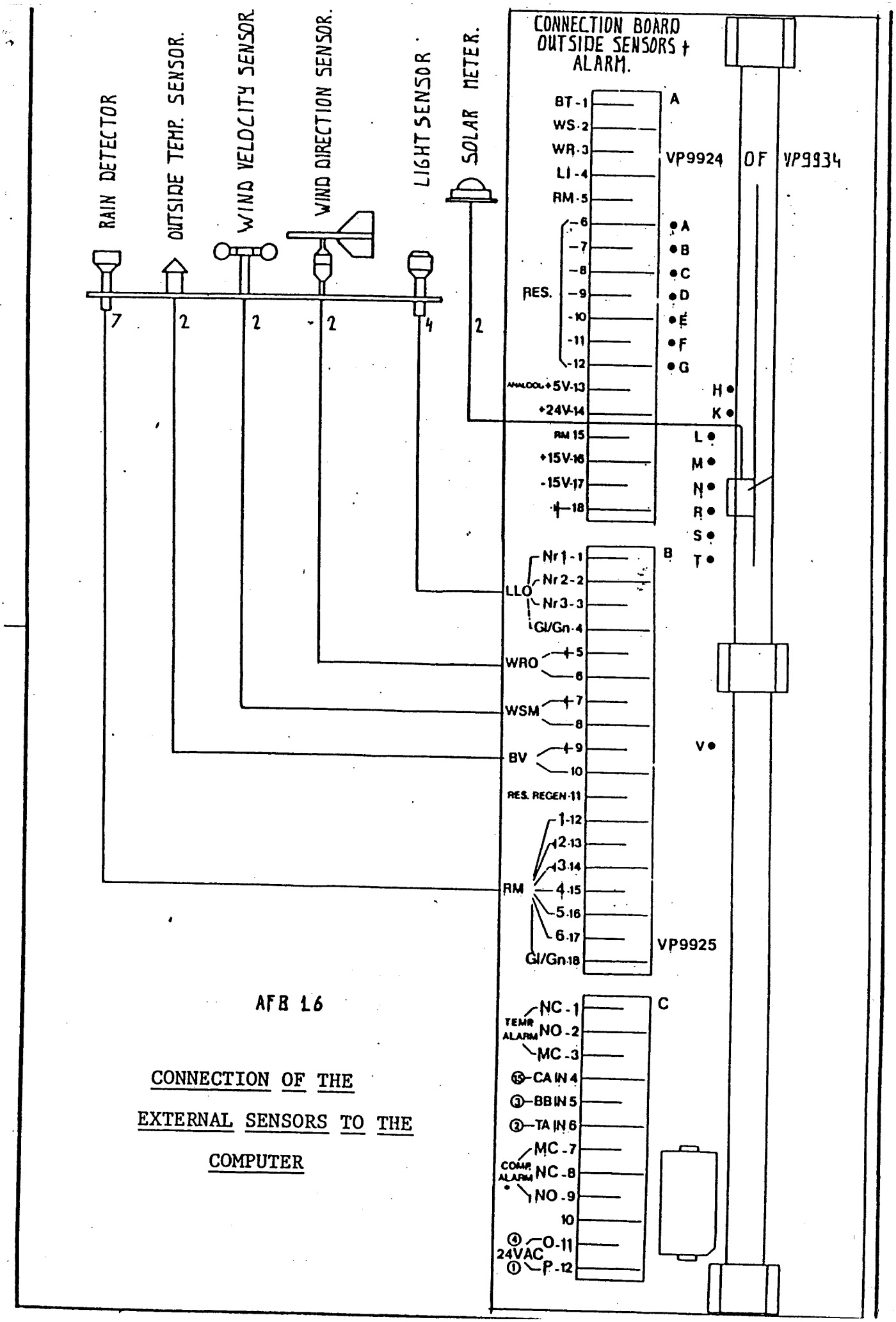
VERVANG TEK NR

PRIVA b.v.
Zijlweg 3
2678 LC de Lier

Betreft

CODE NR.

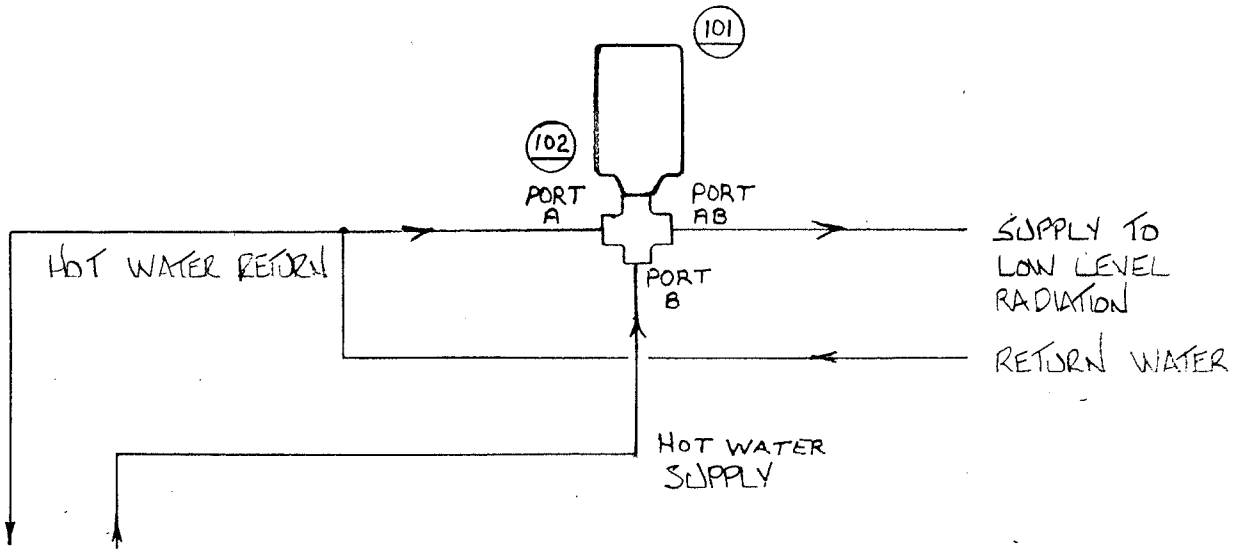
TEK NR. 310010003



AFB 1.6

CONNECTION OF THE EXTERNAL SENSORS TO THE COMPUTER

GLASSHOUSE 3-WAY MIXING VALVE PIPING SCHEMATIC CV7 TO CV15



101. MP485, 120 Volt, Actuator Proportional Electric.

102. C.V. 7,8, and 9
VB9313-6, 3/4 Inch Mixing Valve Body, 3-Way.

C.V. 10,11,12,13,14, and 15.
VB9313-4, 1/2 Inch Mixing Valve Body, 3-Way.

FLOW PATTERN TABLE

BODY PART NUMBER	FLOW TYPE	STEM UP (S.U.)		STEM DOWN (S.D.)	
		FLOW	CLOSED PORT	FLOW	CLOSED PORT
VB9313-4 VB9313-6	MIXING	B TO AB	A	A TO AB	B

JOB NAME PACIFIC FOREST RESEARCH - PHASE IIB
LOCATION VICTORIA B.C.
ARCHITECT WADE WILLIAMS PARTNERSHIP
ENGINEER D.W THOMSON CONSULTANTS
CONTRACTOR TECH MECHANICAL SYSTEMS

BARBER COLMAN COMPANY
FIELD OFFICE

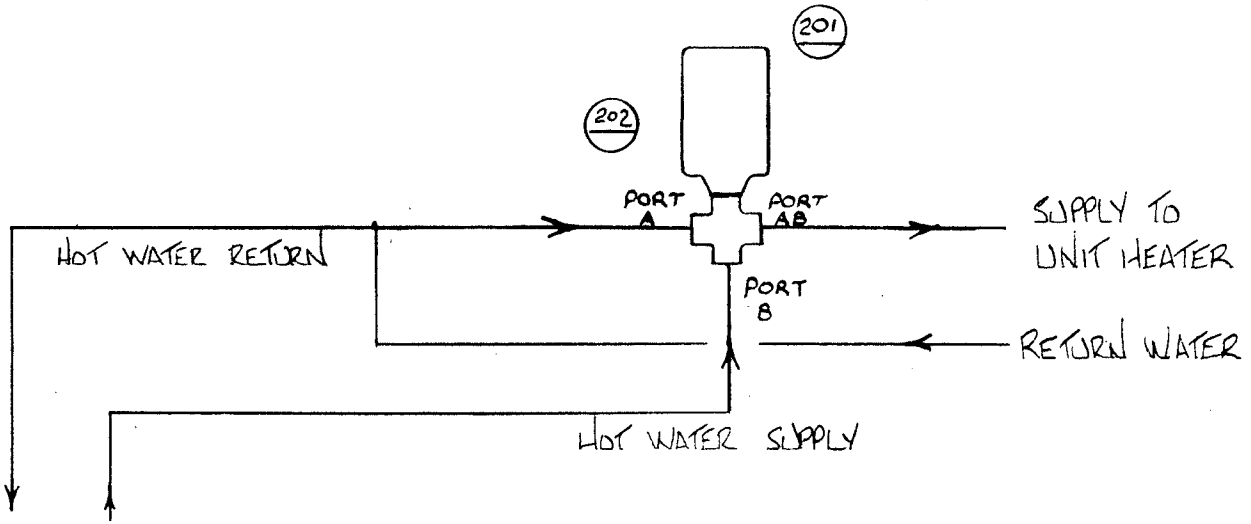
ISLAND TEMPERATURE CONTROLS LTD.
152 MOSS ST. VICTORIA
V8V 4M3

DRAWN BY F.O.
CHECKED
DATE OCT. 11 1984
JOB NO. 8403

F-8039

HEADER HOUSE 3-WAY MIXING VALVE PIPING SCHEMATIC

C.V. 43, 44, 45..



201. MA5210-500, 120 Volt, 2 Position Actuator, Electric with Endswitch.

202. VA9313-201-4-4, 1/2 Inch Mixing Valve, complete with 24 Volt MA5213 Actuator.

FLOW PATTERN TABLE

BODY PART NUMBER	FLOW TYPE	STEM UP (S.U.)		STEM DOWN (S.D.)	
		FLOW	CLOSED PORT	FLOW	CLOSED PORT
VA9313-201-4-4	MIXING	B TO AB	A	A TO AB	B

JOB NAME PACIFIC FOREST RESEARCH- PHASE II B
LOCATION VICTORIA B.C.
ARCHITECT WADE WILLIAMS PARTNERSHIP
ENGINEER D.W. THOMSON CONSULTANS
CONTRACTOR TECH MECHANICAL SYSTEMS

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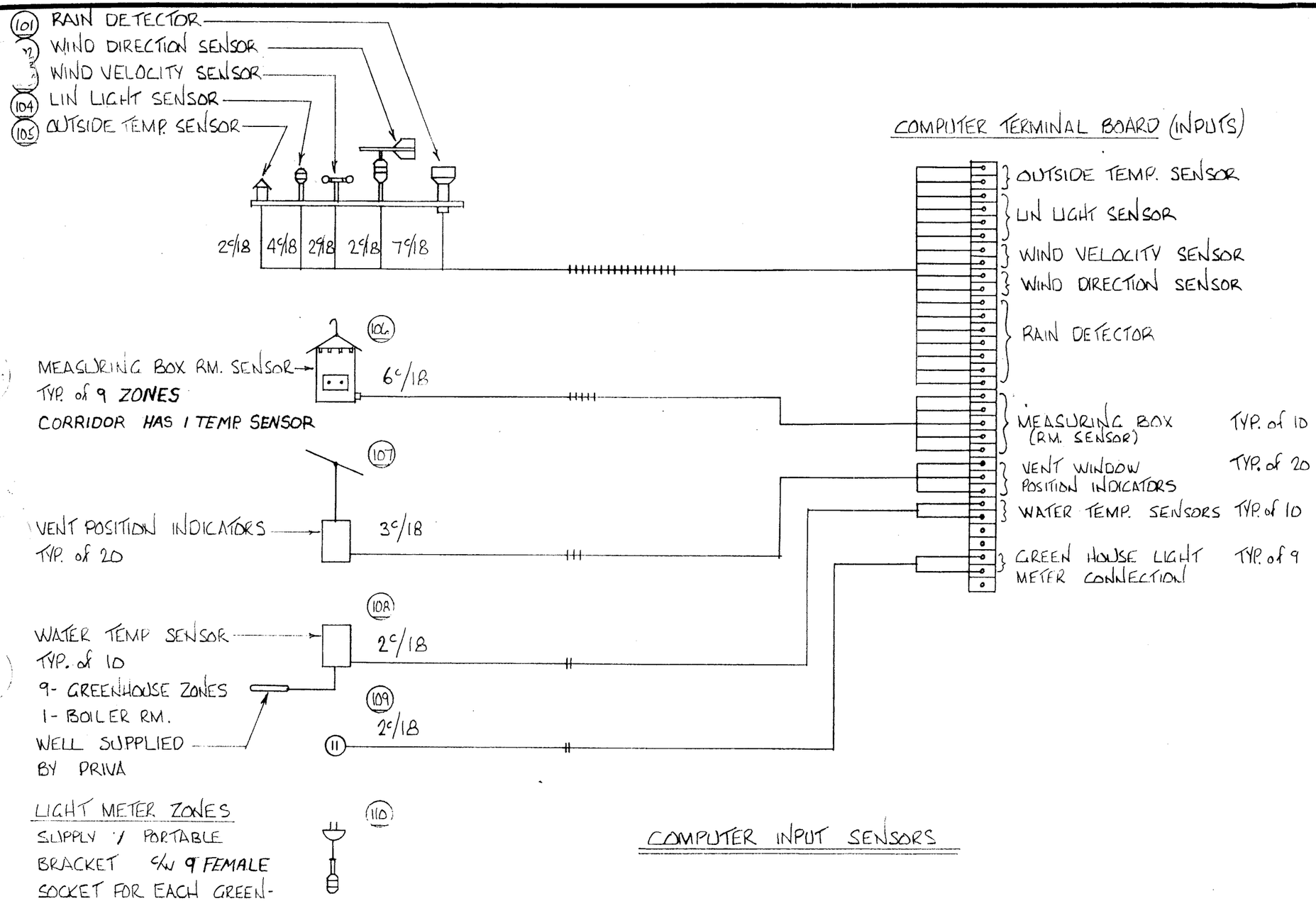

EQUIPMENT LIST

101. Rain Cell Priva R.O.N. # 2184.
102. Wind Direction Sensor Priva W.R.O. # 1670.
103. Wind Velocity Sensor Priva N8. 510182.
104. Light Sensor Kipps Solarmeter Serial # 838993.
105. Outside Temperature Sensor.
106. Measuring Box Sensor (a). Temperature Sensor Priva # BLV (b).
107. Vent Position Indicators Priva # 77.12198.
108. Water Temperature Sensor Priva.
109. Light Meter Socket Priva.
110. Portable Light Meter (1 only) with Bracket.

COMPUTER INPUT SENSORS

SHEET 1 of 8

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— REVISIONS —	
DATE	CHANGES

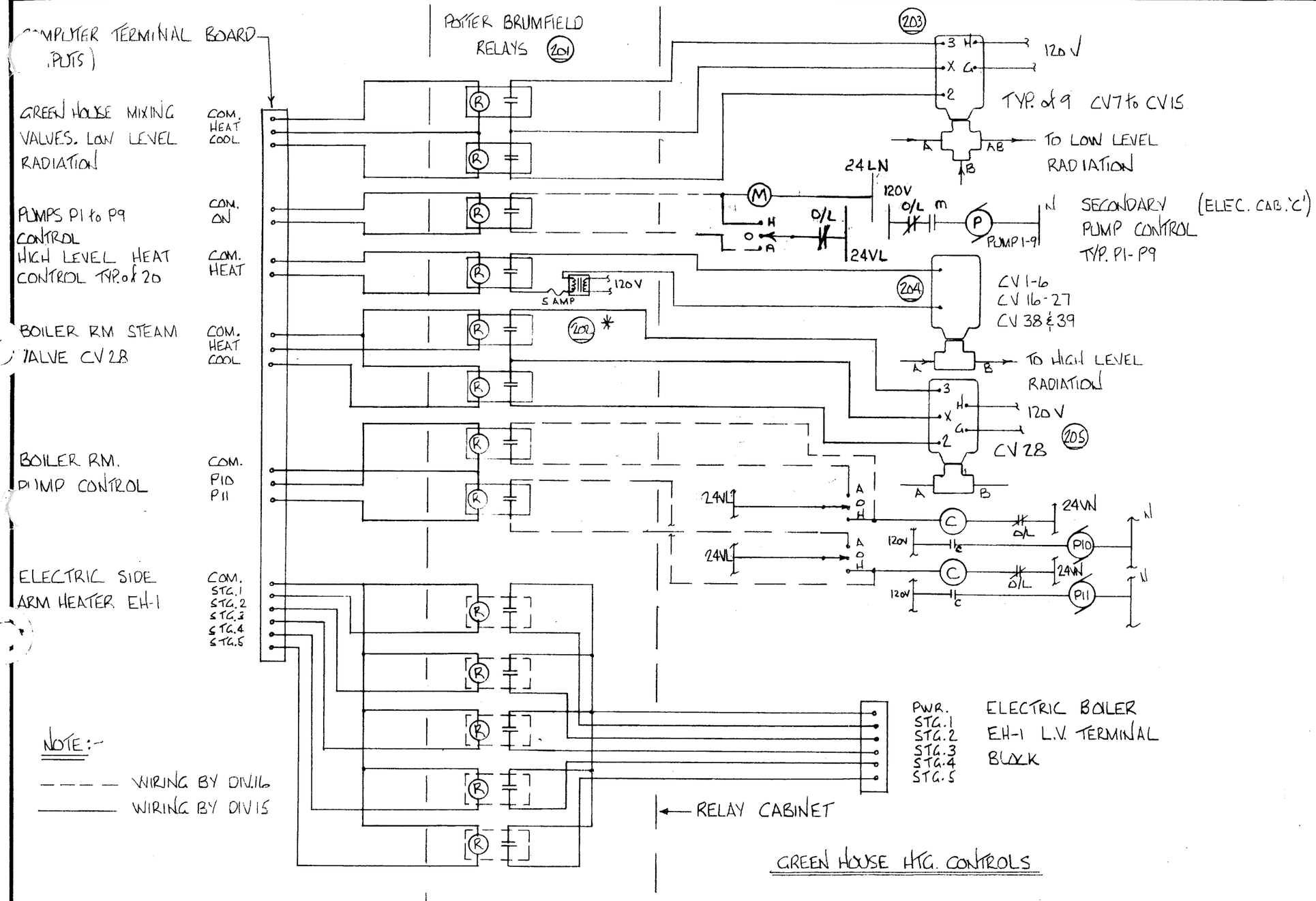
JOB NAME PACIFIC FOREST RESEARCH CENTRE-PHASE II B
LOCATION VICTORIA B.C.
ARCHITECT WADE WILLIAMS PARTNERSHIP
ENGINEER D.W. THOMSON CONSULTANTS
CONTRACTOR TECH MECHANICAL SYSTEMS LTD.

BARBER COLMAN COMPANY
FIELD OFFICE

ISLAND TEMPERATURE CONTROLS LTD.
152 MOSS ST. VICTORIA B.C.
V8V4M3

DRAWN BY T.L.
CHECKED
DATE AUG. 24, 1984
JOB No 8403

F-2968-1



EQUIPMENT LIST

201. Potter Brumfield Relays

S.P.D.T. KRP5AG
D.P.D.T. KRP11AG
3.P.D.T. KRP14AG

202. Hammond Transformer, 120 V. - 24 V., 50VA.

Note: To Divide Valve Load, use 3 Transformers of this rating.

203. A) C.V. 7, 8, and 9.
VB9313-6, 3/4 Inch Mixing Valve, complete with MP485 Actuator.

B) C.V. 10, 11, 12, 13, 14, and 15.
VB9313-4, 1/2 Inch Mixing Valve, complete with MP485 Actuator.

204. C.V. 1, 2, 3, 4, 5, and 6.
C.V. 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, and 27.
C.V. 39.
VA9221-201-4-4, 1/2 Inch Normally Closed Valve, complete with MA5213 Actuator.

205. VB9283-0-4-6, 3/4 Inch Valve, complete with MP475 Actuator.

GREEN HOUSE HTG. CONTROLS

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— REVISIONS —	
DATE	CHANGES

JOB NAME PACIFIC FOREST RESEARCH CENTRE – PHASE II B
LOCATION VICTORIA B.C.
ARCHITECT WADE WILLIAMS PARTNERSHIP
ENGINEER D.W. THOMSON CONSULTANTS
CONTRACTOR TECH MECHANICAL SYSTEMS LTD.

BARBER COLMAN COMPANY
FIELD OFFICE

ISLAND TEMPERATURE CONTROLS LTD.
152 MOSS ST. VICTORIA B.C.
V8V 4M3

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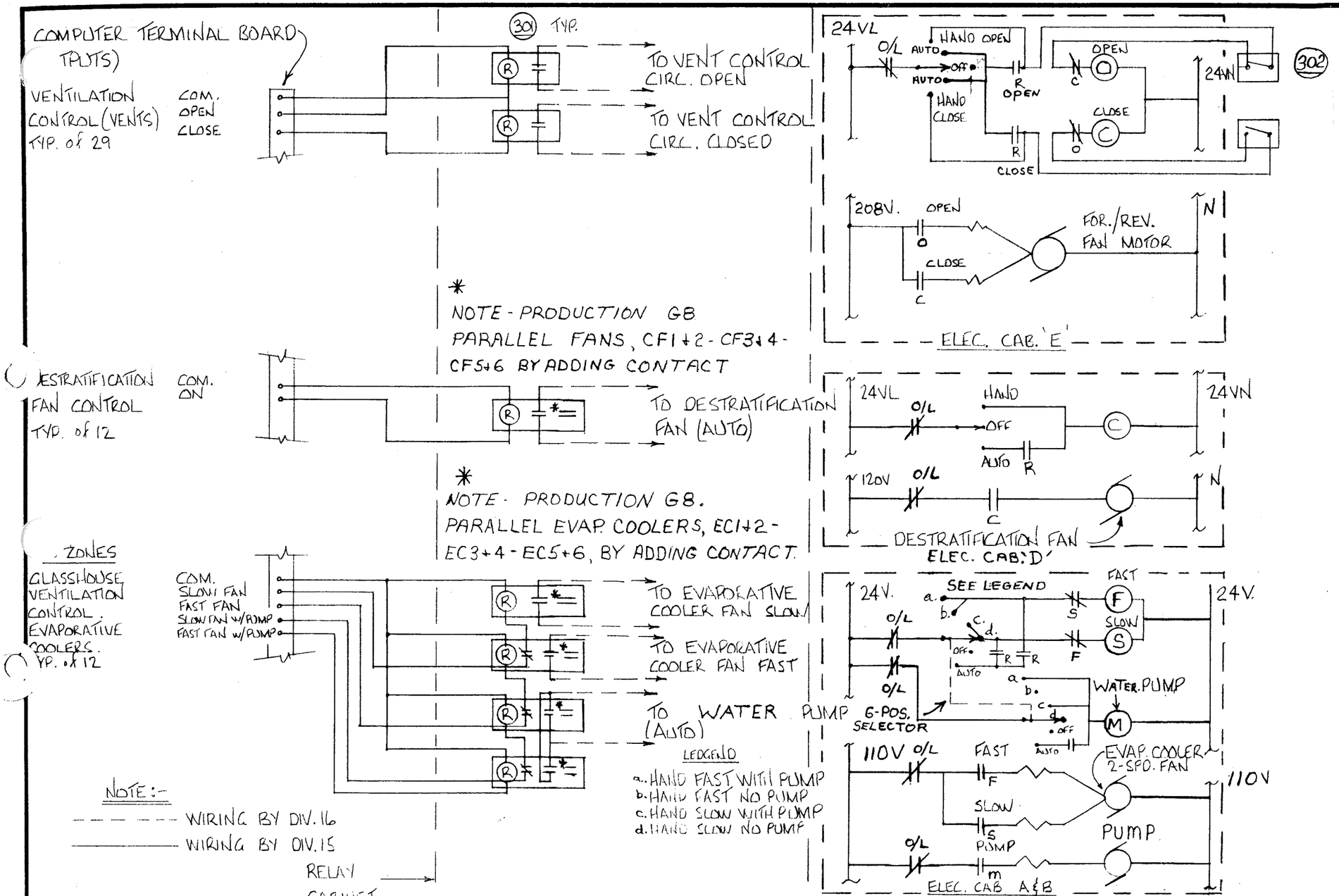
CHECKED
DATE N.Y. 24, 1984
JOB NO 8403

F-2968-1



EQUIPMENT LIST

301. Potter Brumfield Relays.

S.P.S.T.	KRP5AG
D.P.D.T.	KRP11AG
3.P.D.T.	KRP14AG

302. Torque Limit Switch, supplied by others.

GLASSHOUSE VENTILATION CONTROL

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JOB NAME PACIFIC FOREST RESEARCH CENTRE - PHASE IIB
LOCATION VICTORIA B.C.
ARCHITECT WADE WILLIAMS PARTNERSHIP
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CONTRACTOR TECH MECHANICAL SYSTEMS LTD.

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152 MOSS ST. VICTORIA B.C.
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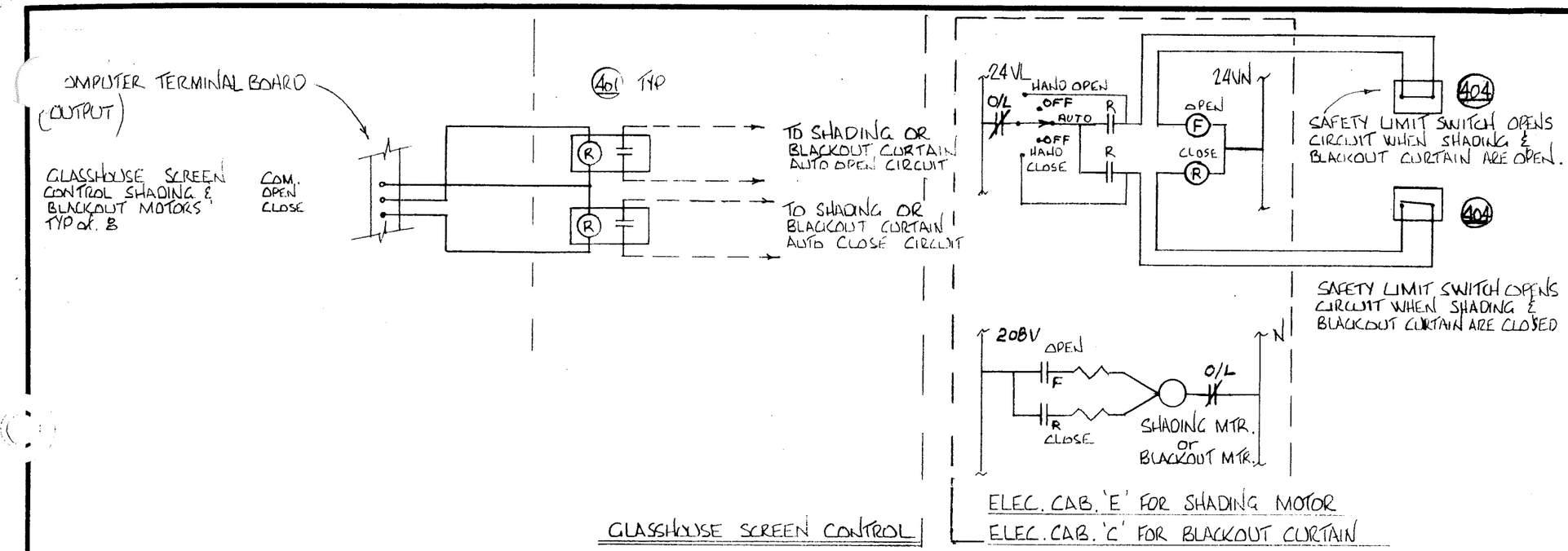
DATE AUG. 24, 1984
JOB NO 8403

F-2968-1



EQUIPMENT LIST

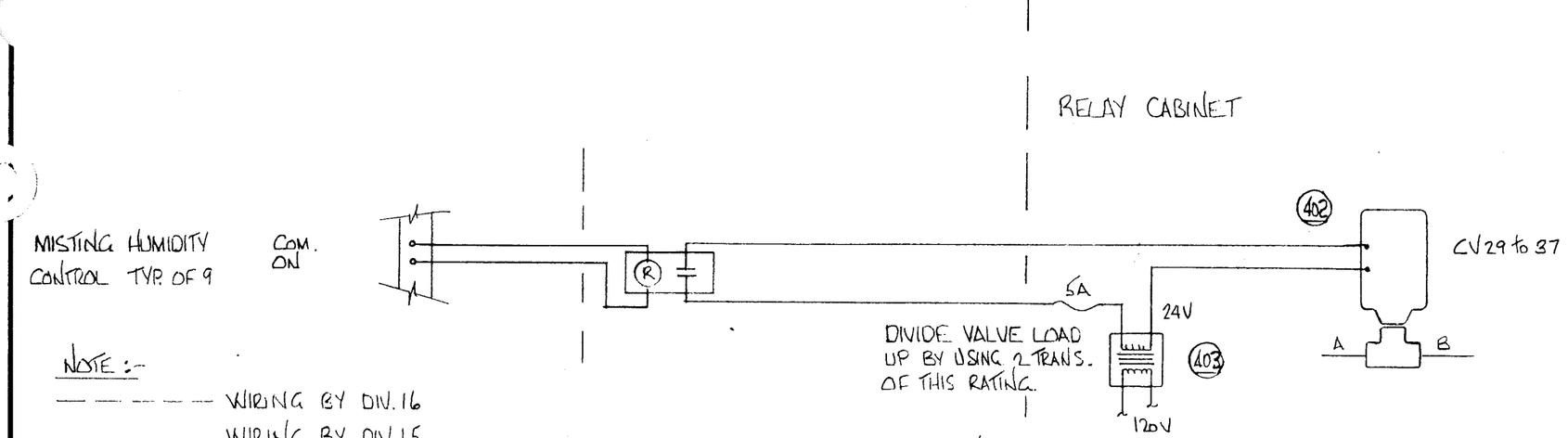
401. Potter Brumfield Relays.

S.P.S.T. KRP5AG
D.P.D.T. KRP11AG
3.P.D.T. KRP14AG

402. VB9221-201-4-4, 1/2 Inch, N.C. Valve, complete with MP5213 Actuator.

403. Hammond, 120 V. - 24 V. Transformer, 100 VA.

404. Torque Limit Switch, supplied by others.



NOTE :-

— — — — — WIRING BY DIV. 16

———— WIRING BY DIV. 15

GLASSHOUSE HUMIDITY CONTROL - 9 ZONES

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REVISED OCT. 24, 1984

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JOB NAME PACIFIC FOREST REASEARCH CENTRE - PHASE IIB
LOCATION VICTORIA B.C.
ARCHITECT WADE WILLIAMS PARTNERSHIP
ENGINEER D.W. THOMSON CONSULTANTS
CONTRACTOR TECH MECHANICAL SYSTEMS LTD.

BARBER COLMAN COMPANY
FIELD OFFICE

ISLAND TEMPERATURE CONTROLS LTD.
152 MOSS ST. VICTORIA B.C.
V8V 4M3

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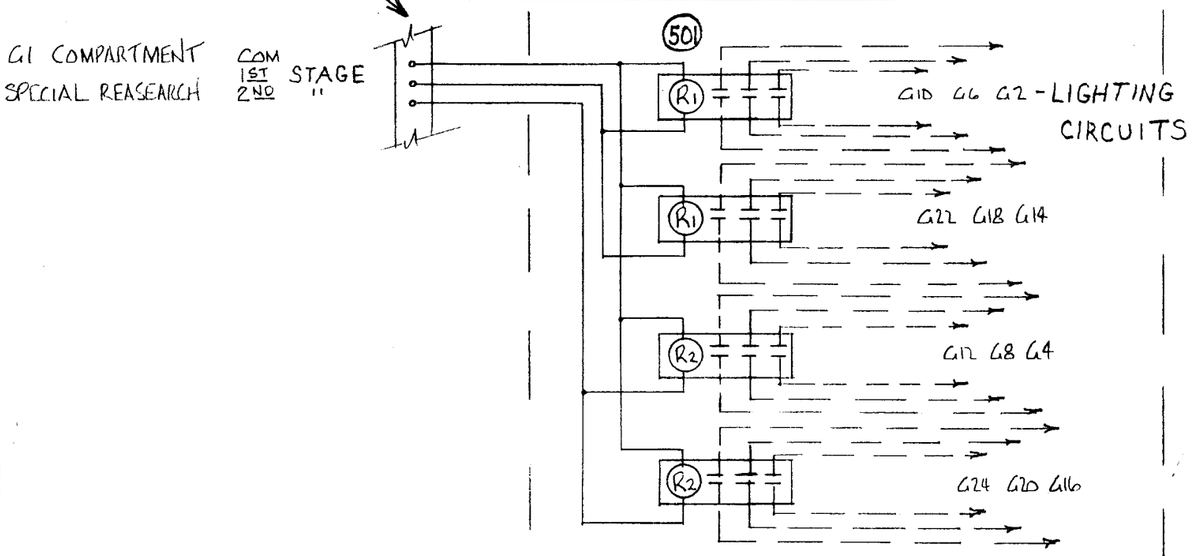
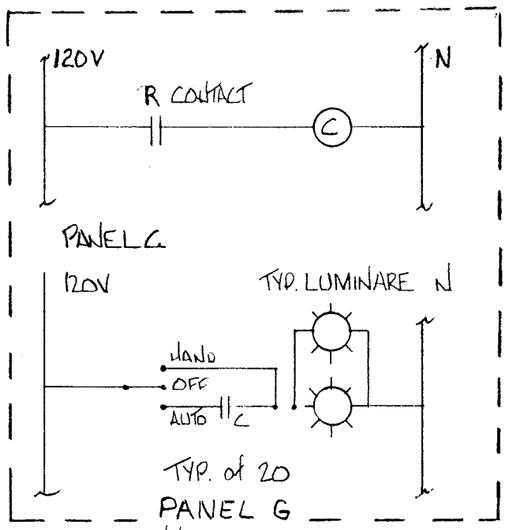
CHECKED
DATE AUG. 24 1984
JOB No 8403

F-2968-1

COMPUTER TERMINAL BOARD

GLASSHOUSE LIGHTING CONTROL





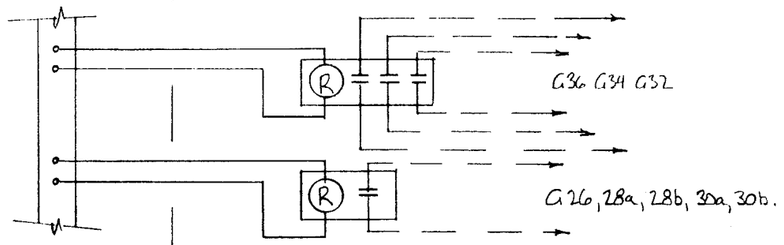
GREENHOUSE LIGHTING CONTROL PANEL

EQUIPMENT LIST

501. Potter Brumfield Relays

S.P.S.T. KRP5AG
D.P.D.T. KRP11AG
3.P.D.T. KRP14AG

← RELAY CABINET



NOTE:-

— — — — — WIRING BY DIV. 16

———————— WIRING BY DIV. 15

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REVISED OCT. 24, 1984

— REVISIONS —	
DATE	CHANGES

JOB NAME PACIFIC FOREST RESEARCH CENTRE - PHASE IIB
LOCATION VICTORIA B.C.
ARCHITECT WADE WILLIAMS PARTNERSHIP
ENGINEER D.W. THOMSON CONSULTANTS
CONTRACTOR TECH MECHANICAL SYSTEMS LTD.

BARBER COLMAN COMPANY
FIELD OFFICE

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152 MOSS ST. VICTORIA B.C.
V8V 4M3

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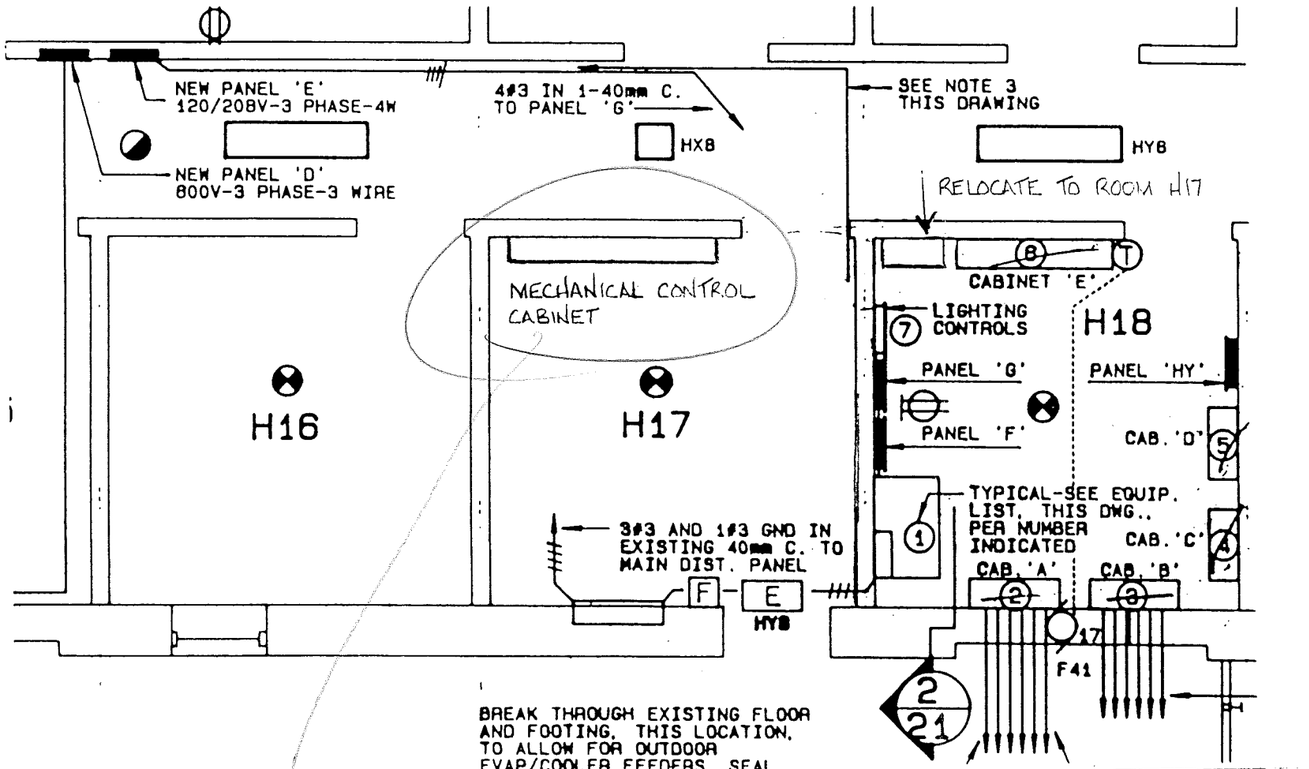

SHEET 8 of 8

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DATE	CHANGES

JOB NAME PACIFIC FOREST RESEARCH CENTRE - PHASE IIB
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ENGINEER D.W. THOMSON CONSULTANTS
CONTRACTOR TECH MECHANICAL SYSTEMS LTD.

BARBER COLMAN COMPANY
FIELD OFFICE

ISLAND TEMPERATURE
CONTROLS LTD.
152 MOSS ST. VICTORIA B.C.
V8V 4M3

DRAWN BY T.L.
CHECKED
DATE AUG. 24, 1984
JOB NO 8403

F-2968-1

Appendix C

Hazardous Materials Survey

Pacific Forestry Centre

Header House and Annex

Hazardous Materials Survey

Pacific Forestry Centre

Header House and Annex

[redacted]

[redacted]

Prepared for:

Prepared by

North West Environmental Group Ltd.

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NWE Project: 11063

JM Bean
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North West Environmental Group Ltd.

Table of Contents

EXECUTIVE SUMMARY

A hazardous materials risk assessment of the Header House and Annex buildings located at the Pacific Forestry Centre in Victoria, BC was conducted on January 6th and 7th, 2010 on behalf of JM Bean. Suspect hazardous materials were identified, logged and, where necessary, sampled to determine the presence of hazardous materials.

Typical insulating and surfacing materials observed within the buildings were examined, sampled and analyzed during the survey. These included interior and exterior wall materials, flooring, and mechanical insulation samples collected.

The buildings were occupied during the survey and samples were collected utilizing non invasive techniques. Even with the most invasive survey techniques, however, it should be noted that the possibility remains for other concealed materials to be found during the demolition process. When the building is completely vacant, prior to demolition or extensive renovations, further destructive testing is recommended.

WorkSafeBC Regulations require that all hazardous materials including asbestos be identified and where impacted by the renovation be removed.. Removal of hazardous materials must be undertaken by a qualified contractor employing WorkSafeBC approved procedures. If materials are encountered during deconstruction that differ from, or are in addition to those reported in the bulk sample collection report, then work must stop until the material content can be determined.

The purpose of this hazard assessment was to identify the locations of asbestos and other hazardous materials prior to sprinkler upgrades are carried out within the buildings. This report includes a list of building materials that are confirmed or suspected of containing hazardous materials.

The survey identified the following hazardous materials within Header House and Annex Buildings

Asbestos – Header House Building	
▪	Drywall Joint Filler Compounds on walls and ceilings.
▪	Floor tiles, levelling compounds and mastics.
▪	Fumehood in Room H8
▪	Cement Wall Board within the perimeter Heater Casing in Rooms H3, H5, H6, H7, H8 and H9
▪	Asbestos gasket suspected to be in rain leaders drain connections
▪	Roofing membranes and mastics (suspected)
Lead	
•	Lead based or lead containing paint is present within the interior and exterior paints.
•	Lead is suspected to be in rain water leaders at the drain connections
Bio- Hazard Rodent Droppings	
•	No rodent droppings were observed. However, precautions should be implemented if wall, ceiling cavities and attic cavities are opened.
Mercury	
•	Thermostats in Building
•	Fluorescent Lights
Radioactive materials	
•	Smoke detectors

PCBs	
•	Fluorescent light ballasts
Mould	
•	Mould was not observed within this building

Asbestos – Annex Building	
▪	Drywall Joint Filler Compounds on walls and ceilings.
▪	Floor tiles, levelling compounds and mastics.
▪	Asbestos gasket suspected to be in rain leaders drain connections
▪	Roofing membranes and mastics
Lead	
•	Lead based or lead containing paint is present within the interior and exterior paints.
•	Lead is suspected to be in rain water leaders at the drain connections
Bio- Hazard Rodent Droppings	
•	No rodent droppings were observed. However, precautions should be implemented if wall, ceiling cavities and attic cavities are opened.
Mercury	
•	Thermostats in Building
•	Fluorescent Lights
Radioactive materials	
•	Smoke detectors
PCBs	
•	Fluorescent light ballasts
Mould	
•	Mould was observed within Room 42

Where hazardous materials were found they can be presumed to be found in similar materials throughout the buildings.

- Arsenic containing pressure treated wood was not observed.
- A Stage 1 PSI was not part our our scope of work..

INTRODUCTION

North West Environmental was retained by JM Bean & Co. to conduct a hazardous-material assessment of the Header House and Annex buildings at the Pacific Forestry Centre, Victoria, B.C. prior to installation of a sprinkler system.

All accessible areas of this buildings were inspected for the presence of asbestos-containing materials and other hazardous materials including lead, mercury, and PCBs. Where appropriate, representative samples of materials suspected of containing asbestos or other hazardous materials were collected and sent for confirmatory testing.

Observations were made to determine the presence of mercury-containing thermostats, smoke detectors, urea-formaldehyde foam insulation, as well as aboveground but not underground storage tanks.

WorkSafeBC Regulations require that all hazardous materials including asbestos be identified and where impacted by the renovation be removed. Removal of hazardous materials must be undertaken by a qualified contractor employing WCB approved procedures. If materials are encountered during deconstruction that differ from, or are in addition to those described in this report, then work must stop until the material content can be determined.

REGULATORY CRITERIA

1.1 Polychlorinated Biphenyls (PCB)

Polychlorinated biphenyls (PCB) are regulated under both federal (Canadian Environmental Protection Act) and BC Hazardous Waste Regulation and must be treated as PCB waste and be stored and disposed of accordingly.

Each fluorescent light fixture removed during facility renovation or demolition should have the ballast checked to determine if it contains PCB. Ballasts containing PCB must be removed, sorted and transported to a licensed facility. Although rare, paints have been known to contain PCBs.

1.2 Asbestos

Projects that will result in the disturbance of asbestos-containing materials (ACMs) must satisfy the regulatory requirements of WorkSafeBC's guidance document Safe Work Practices for Handling of Asbestos. WorkSafeBC's Occupational Health and Safety Regulation defines an asbestos-containing material as "any manufactured article or other material which contains one (1) per cent or more asbestos by weight at the time of manufacture, or which contains one (1) per cent or more asbestos as determined by NIOSH Analytical Method 9002 (dispersion staining, polarized light microscope) or x-ray diffraction".

Asbestos is identified by its fibrous morphology and optical properties and is classified as being either: 1) chrysotile; 2) crocidolite; 3) amosite; or 4) other amphibole asbestos.

The asbestos-containing material can also be characterized as friable and non-friable. Friable asbestos "means any material which, when dry, can be easily crumbled or powdered by hand pressure, or a material that is crumbled or powdered" as defined under the BC Occupational Health and Safety Regulation. The condition of the asbestos and classifications would be used in assessing the level of action required with respect to re-use of the building.

Worker exposure to asbestos fibres is also regulated by the BC Occupational Health and Safety Regulation. The WCB eight-hour TWA for asbestos fibres (all forms) is 0.1 fibre/cm^3. Exposure to these substances must be kept as close to zero as is reasonably practicable.

British Columbia has adopted monitoring criteria during asbestos-abatement projects that are based on the classification of projects into three risk categories. Daily air monitoring during asbestos abatement is not required when low or moderate risk procedures are to be employed. Some limited air monitoring is required, however, for the purposes of verifying that the procedures employed are effective at keeping airborne concentrations of asbestos fibres below regulated limits and to ensure that respiratory protection is adequate. However, when high-risk abatement procedures are employed, the WCB of BC criteria specify daily air monitoring within the "clean area", within the "work area" and in any adjacent, occupied area. Asbestos air monitoring in BC must be performed in accordance with NIOSH Analytical Methods 7400 or another method acceptable to the WCB of BC. In addition, clearance samples of the air in the areas where abatement has been completed must be collected.

Bulk samples are collected in accordance with NIOSH Analytical Method 9002 and the WCB of BC guideline document, Safe Work Practices for Handling Asbestos.

1.3 Mercury

Mercury is hazardous substance, and any maintenance or abatement involving materials containing mercury or mercury compounds must be done in compliance with the BC Occupational Health and Safety Regulations (BCOHSR).

As a hazardous substance, transportation and disposal of mercury must be in compliance with the federal Transportation of Dangerous Goods (TDG) Regulations and the BC Hazardous Waste Regulation. Mercury is found in fluorescent light bulbs, thermostats as well as electrical switches.

1.4 Arsenic

Arsenic has long been used as a pesticide due to its toxic properties. Arsenical pesticides, often in the form of chromated copper arsenate (CCA), when applied with high pressure to wood, serve to extend the structural life of the material by making it resistant to mould, rot and insect infestation. Studies have shown that these materials have the ability to leach arsenic into the soil. Arsenic may also be found in paints. Although wood and wood dusts contaminated with arsenical pesticides do not require specialized disposal in BC, care must be exercised to minimize the potential for worker exposure to these materials through direct skin contact or through inhalation of dusts and fumes.

1.5 Ozone-depleting Substances (CFCs/ODS)

Chlorofluorocarbons (CFCs) are ozone-depleting substances (ODS) and a type of halocarbon. ODS are regulated by the Canadian Environmental Protection Act under the Ozone-Depleting Substances Regulations 1998 SOR/99-7 and the Federal Halocarbon Regulations (FHR) SOR/99-225. Compounds that contain only chlorine, fluorine and carbon are called CFCs. These materials are used in refrigeration systems and in fire suppression systems. The other main refrigerants are hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs) and blends of fluorocarbons (designated by "R").

While the regulations allow the continued use of halocarbon refrigerants, they strictly prohibit any person from releasing into the environment any halocarbon.

In the case of demolition, these materials will require proper recovery and disposal. The BC Ozone-Depleting Substances Regulations would also apply to any CFC/ODS abatement procedures. These regulations require that all ODS must be collected, stored and recycled, or collected and disposed accordingly.

1.6 Urea Formaldehyde Foam Insulation

Urea Formaldehyde Foam Insulation (UFFI) was banned in 1978. All such material was to have been removed and replaced. Standard real estate agreements currently contain a "No UFFI" clause and as a best management practice, all buildings containing UFFI should have the material removed.

1.7 Radioactive Materials

Residential structures routinely house small sealed radioactive sources in the form of ^{241}Americium which is found in smoke detectors. The Canadian Nuclear Safety Commission (CNSC) and the Canadian Nuclear Safety Act regulate radioactive materials. These materials are sealed into a metal case within the smoke detector and must not be damaged or tampered with. Smoke detectors intended for disposal must be handled in accordance with CNSC regulations.

1.8 Aboveground / Underground Storage Tanks

Storage tanks containing fuels have the ability to leak over time and can result in soil and groundwater contamination. These tanks must be observed and checked over time to ensure they do not leak. Evidence of leaks must be investigated and any potential contamination remediated. Underground storage tanks were not visually identified during this investigation. A Stage 1 PSI was not a part of our scope of work.

1.9 Lead

Most houses and buildings built before 1950 have had lead-based paint applied to the interior or exterior surfaces. In most cases, lead paint of this era contained up to 40% lead by weight. Paints made between 1950 and 1978 usually contained smaller amounts of lead.

Lead is a designated substance and as such is regulated under the BC Occupational Health and Safety Regulation. Airborne exposure criteria, respirator requirements and mandatory worker testing requirements are also outlined under this regulation. As with all other designated substances, all personnel working around or with such materials must be made aware of their presence and be supplied with training in the potential health effects and means of avoiding exposures. As leachable lead is a hazardous waste, disposal sites should be contacted in advance to ensure their willingness to accept the waste.

1.10 HantaVirus – Rodent Droppings

This is a disease caught through contact with the urine or droppings, or by being bitten or scratched by infected rodents. The disease starts off like a cold or flu (fever, sore muscles, headaches, nausea, vomiting), but progresses to pneumonia-like conditions within a few days. The change in intensity of the symptoms is very rapid and can result in fluid build up in the lungs and respiratory failure.

1.11 Mould

Within the BC Occupational Health and Safety Regulations, there are no provisions for management of mould contamination in buildings nor are there established permissible levels of mould in air. However, many guidelines are provided for addressing mould in Canada including:

- The Institute of Inspection, Cleaning and Restoration and Certification (IICRC) standard S500 governing both water damage restoration and entitled: Standard for Professional Water Damage Restoration – S500. This document is approved by the American National Standards Institute (ANSI)
- Health Canada: Fungal contamination in public buildings: A guide to recognition and management, 1995
- Health Canada. Fungal Contamination in Public Buildings: Health Effects and Investigation Methods, 2004
- CSA 317.13-03 Standard - Infection Control During Construction or Renovation of Health Care Facilities

These guidelines also state that any non-porous (metal, glass and hard plastics) and semi-porous (wood and concrete) materials that are structurally sound and visibly mouldy can be cleaned and re-used. However, porous materials such as ceiling tiles, wallpaper, insulation, drywall, and sometimes carpets with more than a small area of contamination should be removed and discarded.

FINDINGS

1.12 Polychlorinated Biphenyls (PCB)

Fluorescent light fixtures and ballasts were observed within the Annex Building during the survey. If the light fixtures are to be removed during the sprinkler upgrade then any fluorescent light fixture should be checked to ensure that ballasts do not contain PCB's. If PCB's are found to be present, the ballasts should be removed and disposed in accordance with Ministry of Environment regulations.

Paints were not tested for PCB content.

1.13 Asbestos

1.13.1 Bulk Samples

Bulk samples of building materials suspected of containing asbestos were collected from a number of areas within the Header House and Annex Buildings. These materials included drywall joint compound, sheet flooring, floor tiles, fume hoods, heaters, pipe and vessel insulation, and interior wall finishes. All samples of materials suspected of containing asbestos were analyzed for asbestos content.

Samples of building materials were obtained by cutting, scraping or breaking away a small piece of the material. Samples of vinyl sheet flooring were obtained either by cutting a core through all layers of flooring material including the subfloors using an electric drill fitted with a hole saw or trimming pieces off a previously exposed perforation in the floor such as a heating register. The samples were then placed in a self-closing plastic bag, sealed and labelled. A chain of custody was prepared for all samples collected. Asbestos bulk samples were analyzed to determine the type and approximate content of asbestos.

Twenty (20) representative bulk samples were collected and analyzed for asbestos.

Header House Building - Asbestos was found in the following locations:

• **Drywall Joint Filler Compounds –** throughout the building
• **Floor Tiles**– All Floor Tiles, levelling compound and mastics. All floor tiles within the building contain asbestos..
• **Fume Hood in Room H8** – Base, walls and ceiling of the fume hood is asbestos containing.
• **Perimeter Heater Wall Board (concealed) –** this cement board is on the inside wall of the heater unit located in Rooms H3, H5, H6, H7, H8 and H9. The heater unit is covered with a decorative wood panel.
• **Roofing membranes and Felts –** this material is suspected to contain asbestos.
• **Rain Water Leaders –** the inside of the bell and spigot is often lined with a rope material that contains asbestos.

NOTE 1*: Throughout the building, asbestos gasket is suspected to be in rain leaders drain connections*

Copies of the analytical reports are provided in Appendix 1.

NOTE 2: Roofing membranes will have to be sampled if they are to be disturbed or damaged during renovations or building demolition. Often the sampling takes place once the building is unoccupied and electrical power to the building has been disconnected. Until such time all roofing membranes and mastics are to be assumed asbestos containing.

Annex Building - Asbestos was found in the following locations:

• **Drywall Joint Filler Compounds –** throughout the building
• **Floor Tiles**– All Floor Tiles, levelling compound and mastics. The floor tiles are located in the Men's and Women's washrooms..
• **Roofing membranes and Felts –** this material is suspected to contain asbestos.
• **Rain Water Leaders –** the inside of the bell and spigot is often lined with a rope material that contains asbestos.

NOTE 3*: Throughout the building, asbestos gasket is suspected to be in rain leaders drain connections*

Copies of the analytical reports are provided in Appendix 1.

NOTE 4: Roofing membranes will have to be sampled if they are to be disturbed or damaged during renovations or building demolition. Often the sampling takes place once the building is unoccupied and electrical power to the building has been disconnected. Until such time all roofing membranes and mastics are to be assumed asbestos containing

1.14 Mercury

Mercury-containing thermostats were observed within the buildings.. Mercury containing thermostats should be removed prior to disturbance and must be packaged for transport and storage or disposal/destruction at a licensed facility. Alternatively, the thermostat, if functional, could be re-used for its original intended purpose.

Mercury is also found in minute quantities within the fluorescent light tubes. Caution should be exercised to ensure light tubes are not broken, releasing droplets of mercury.

1.15 Arsenic

Wood likely to have been preserved with arsenical pesticides was not observed on the subject site.

1.16 Ozone-depleting Substances (CFCs/ODS)

Refrigerators that may use chlorofluorocarbons (CFCs) or ozone-depleting substances (ODS) are present within the coolers located within the header building. In the case of renovation impacting these unit or demolition, these materials will require proper recovery and disposal. The BC Ozone-Depleting Substances Regulations would also apply to any CFC/ODS abatement procedures. These regulations require that all ODS must be collected, stored and recycled, or collected and disposed accordingly.

1.17 Urea Formaldehyde Foam Insulation

No sampling was undertaken for Urea Formaldehyde Foam Insulation (UFFI) as the presence of UFFI was not noted in the buildings.

1.18 Radioactive Materials

Smoke detectors containing sealed ^{241}Americium sources were identified in the buildings. These smoke detectors should be collected and disposed in accordance with Canadian Nuclear Safety Commission regulations.

1.19 Aboveground Storage Tanks

Fuel storage tanks were not observed in the buildings.

1.20 Lead

1.20.1 Lead Paint

Painted surfaces such as interior and exterior wall surfaces, window frames and original wood exterior coatings contain lead. Lead based, or containing paints were commonly used during the era of operation for these buildings and all original surface coatings should be considered to be lead containing.

Options for dealing with the lead paint are to strip the paint and dispose of only the paint, or to dispose of the paint and substrate (i.e. wood and concrete). In either case, the material may have to be disposed as a Hazardous Waste at a licensed landfill. Soils analysis for lead content around the exterior of the building should also be included and any contaminated soils should be removed and disposed of appropriately.

Although no leachate criteria testing was conducted, experience has shown that lead paints often exceed the leachate quality criteria of the BC Hazardous Waste Regulation. Lead paints if concentrated in the form of chips should be considered hazardous waste and be transported by a licensed carrier and disposed of at a licensed facility. Materials coated with paint containing lead should not be chipped and buried as this destructive disposal method not only has the potential to release significant amounts of hazardous dust, but also increases the potential for hazardous levels of metals to leach from the material substrate. Soils analysis for lead content around the exterior of the building should also be conducted and any contaminated soils should be removed and disposed of appropriately.

Workers should use caution to avoid activities such as sanding or heat stripping of paints containing lead, arsenic or mercury since such activities can create airborne dusts and fumes in concentrations that may pose an inhalation hazard. An effective exposure control plan may include the use of decontamination facilities, respiratory protection, waste handling procedures, and contamination control procedures.

1.20.2 Elemental Lead

Lead is suspected to be in the drain connections of the rain leaders throughout the buildings. If lead materials are found they are typically recognized as having significant salvage value, disposal is therefore should not be a major concern. Workers should exercise caution if heat is to be used to melt any lead found as means of facilitating its extraction. Molten lead can produce significant quantities of inhalable lead fume which can pose a severe health hazard. The BC Occupational Health and Safety Regulation requires that worker exposure to airborne lead be kept to 0.05 mg/m^3.

Lead within the copper water pipes/fittings was not tested for lead content however lead content in solder is known to reach levels up to 98% lead.

1.21 HantaVirus – Rodent Droppings

Rodent droppings were not observed within either of the buildings.

1.22 Mould

Mould was observed present in Room 42 of the Annex building. The extent of the mould suspected to be present in this room is estimated to be less than 10m2 in size. According to Guideline G4.79 (Moulds and indoor air quality) of the Occupational Health and Safety Regulation, the extent of mould contamination would rate as 'medium.

Table 1: Guide for Removing Visible Mould Growth in the Indoor Environment

Extent of Visible and Hidden Mould Growth (surface area)	Minimum Recommended PPE	Control Measures to Prevent Dust or Spore Dispersion
Medium Total surface area affected is between 1 square metre and 10 square metres (10 square feet to 100 square feet)	N95 respirator or half facepiece respirator with HEPA filters, gloves, disposable coveralls, and goggles.	Limited containment: use polyethylene sheeting ceiling to floor around the affected area with a slit entry and covering flap. Maintain area under negative pressure with HEPA filtered negative air unit. Block supply and return air vents within the containment area.

CONCLUSIONS AND RECOMMENDATIONS

1. Based on the above stated conclusions, the following recommendations are provided.

2. Provide copies of this report, or a summary thereof, to site personnel as required, including contractors.

3. Suspect materials encountered other than what has been identified during the installation of sprinklers should be left undisturbed until testing determines the presence or absence of asbestos.

4. The asbestos containing floor tiles, levelling compounds and mastics within the buildings can remain in place if they are not impacted by the upcoming renovations. If they are to be disturbed then the floor tiles will need to be removed and abated following Moderate Risk Work Procedures following appropriate WorkSafeBC asbestos abatement techniques. The floor tiles are present in both the Header House and Annex buildings including under millwork, cabinetry and walls..

5. Minor damage to drywall walls and ceilings observed in both the Header House and Annex buildings must be repaired and properly sealed following Moderate Risk Asbestos Work Procedures prior to sprinkler work commencing.

6. The asbestos containing drywall joint filler compounds located throughout both the Header House and Annex buildings will be disturbed and damaged during the sprinkler project. Specifications should be prepared outlining the controlled procedures to be followed by the mechanical contractor when working around and on the drywall.

7. Damaged edges in the fume hood should be repaired and sealed.

8. Air samples should be collected in the rooms which have been observed to have heaters which contain cement asbestos board.

9. The cement asbestos board around the heaters should be HEPA vacuumed and sealed with an approved encapsulant.

10. The drain connectors for the rain water leaders should be maintained in an intact condition during the sprinkler upgrade.

11. Workers should use caution to avoid activities such as sanding or heat stripping of paints containing lead, arsenic or mercury since such activities can create airborne dusts and fumes in concentrations that may pose an inhalation hazard.

12. Each fluorescent light fixture removed during demolition should have the ballast checked to determine if it contains PCB. Ballasts containing PCB must be removed, sorted and transported to a licensed facility.

13. If rodent droppings are encountered then the contractor must provide worker instruction on the hazards of rodent droppings and other biohazardous materials, including the types of respirators and protective clothing to be worn.

14. Mercury containing thermostats should be removed if they will be impacted during the

renovation . If removed they should be packaged for transport and storage or disposal/destruction at a licensed facility. Alternatively, the thermostat, if functional, could be re-used for its original intended purpose.

15. Mould is present in Room 42 of the annex buildings. Remove as per 4.11: Table 1.

6. CLOSURE

This survey and assessment report has been prepared exclusively for the client and is intended to provide a delineation of the presence and condition of asbestos-containing materials if present as observed on the date this survey was conducted. The conclusions and recommendations contained in this assessment report are based upon professional opinions with regard to the subject matter. These opinions are in accordance with accepted hygiene assessment standards and practices applicable to these locations and are subject to the following inherent limitations:

The data and findings presented in this report are valid as of the date of the investigation. The passage of time, manifestation of latent conditions or occurrence of future events may warrant further exploration at the properties, analysis of the data, and re-evaluation of the findings, observations, and conclusions expressed in this report.

The data reported and the findings, observations and conclusions expressed in this report are limited by the Scope of Work. The Scope of Work was defined by the request of the client, the time and budgetary constraints imposed by the client, and availability of access to the properties.

Because of the limitations stated above, the findings, observations and conclusions expressed by North West in this report are not, and should not be, considered an opinion concerning compliance of any past or present owner or operator of the site with any federal, provincial or local laws or regulations.

No warranty or guarantee, whether expressed or implied, is made with respect to the data or the reported findings, observations, and conclusions, which are based solely upon site conditions in existence at the time of investigation.

This report may not be used, relied upon, copied, published, or quoted by any party without the written consent of North West Environmental Group, Ltd. Other parties reading this report must independently verify the completeness and accuracy of this report and its contents.

This report and the surveys focused on the presence of building materials and systems that may contain asbestos, lack of commentary or other types of potential hazardous conditions in no way represents a tacit endorsement of such conditions.

Julie Scott-Moncrieff B.Sc.,
Senior Occupational Hygienist

Reviewed by:
W.G. Sullivan, President
North West Environmental Group Ltd.

APPENDIX 1 Sample Report

North West Environmental Group Ltd.

#3 – 835 Devonshire Road
Victoria, B.C. V9A 4T5

Tel:250-384-9695
Fax:250-384-9865
e-mail:northwest@nwest.bc.ca

Asbestos Analysis of Bulk Materials using Polarized Light Microscopy

Client: **JM Bean & CO**

Site: **NRC PFC**

Tuesday, January 12, 2010

Client Job or PO # **0**

NW Project Number: 11084

Sample Number	Location	Date Analysed	Analyst	Description	Phase	%	Asbestos	%	Other Materials	%
11084-01	Header House-10-Boiler	01/10/10	EM	lagging	Grey/White Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous Glass Cellulose	50 35 15
11084-02	Header House-10	01/10/10	EM	Dry Wall Joint Compound	White Non-Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous	100
11084-03	Header House-10-Boiler	01/10/10	EM	45 Elbow	Grey/Yellow Fibrous Heterogeneous	100	None Detected	0	Cellulose Non-Fibrous Mineral Wool	45 40 15
11084-04	Header House-10-Boiler	01/10/10	EM	Dry Wall Joint Compound	White/Cream Non-Fibrous Heterogeneous	100	**Chrysotile**	**< 1**	Non-Fibrous	100
11084-05	Header House--H20	01/10/10	EM	Valve Fitting	Grey Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous Cellulose	65 35
11084-06	Header House-H8	01/10/10	EM	Floor Tile	Green Non-Fibrous Heterogeneous	100	**Chrysotile**	**8**	Non-Fibrous	92
11084-07	Header House-H8	01/10/10	EM	Fumehood Board	Brown/Grey Fibrous Heterogeneous	100	**Chrysotile**	**2**	Non-Fibrous	98
11084-08	Header House - H5	01/10/10	EM	Duct Caulking	Grey Non-Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous	100
11084-09	Header House - H16	01/10/10	EM	Flooring Battleship	Brown Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous Cellulose	70 30

Note: Samples were analyzed by method: EPA/600/R- 93/116 "Bulk Asbestos Analysis by Polarized Light Microscopy". For heterogeneous materials the concentrations may vary.

North West Environmental Group Ltd.

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Asbestos Analysis of Bulk Materials using Polarized Light Microscopy

Client: **JM Bean & CO**

Site: **NRC PFC**

Tuesday, January 12, 2010

Client Job or PO # **0**

NW Project Number: 11084

Sample Number	Location	Date Analysed	Analyst	Description	Phase	%	Asbestos	%	Other Materials	%
11084-10	Header House	01/10/10	EM	Dry Wall Joint Compound	White Non-Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous	100
11084-11	Header House-H8	01/10/10	EM	Heating Register Vent Chase	Grey Fibrous Heterogeneous	100	**Chrysotile**	**15**	Non-Fibrous	85
11084-13	Annex - Electrical Room	01/10/10	EM	Drywall Joint Compound	White/Cream Non-Fibrous Heterogeneous	100	**Chrysotile**	**< 1**	Non-Fibrous	100
11084-14	Header House - Exterior	01/10/10	EM	Cement by Windows	Grey Non-Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous	100
11084-15 Layer 1	Annex Women's Washroom	01/10/10	EM	12x12 Tile	Beige Non-Fibrous Heterogeneous	98	**Chrysotile**	**10**	Non-Fibrous	90
11084-15 Layer 2	Annex Women's Washroom	01/10/10	EM	Mastic	Black Non-Fibrous Heterogeneous	2	None Detected	0	Non-Fibrous	100
11084-16	Annex Rm 42	01/10/10	EM	Ceiling Tile Upper Layer	Tan/White Fibrous Heterogeneous	100	None Detected	0	Cellulose Non-Fibrous	90 10
11084-18	Annex Rm 42	01/10/10	EM	Dry Wall Joint Compound	Cream Non-Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous	100
11084-19	Annex Storage	01/10/10	EM	Dry Wall Joint Compound	Cream Non-Fibrous Heterogeneous	100	**Chrysotile**	**< 1**	Non-Fibrous	100

Note: Samples were analyzed by method: EPA/600/R- 93/116 "Bulk Asbestos Analysis by Polarized Light Microscopy". For heterogeneous materials the concentrations may vary.

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Asbestos Analysis of Bulk Materials using Polarized Light Microscopy

Client: **JM Bean & CO**

Tuesday, January 12, 2010

Client Job or PO # **0**

Site: **NRC PFC**

NW Project Number: 11084

Sample Number	Location	Date Analysed	Analyst	Description	Phase	%	Asbestos	%	Other Materials	%
11084-20	Annex Exterior	01/10/10	EM	Stucco	Grey Non-Fibrous Heterogeneous	100	None Detected	0	Non-Fibrous	100

APPENDIX 2 Photographs

Photo 1.1 – Annex Exterior

Photo 1.2 Annex Building Concealed Fibre Glass Insulation above Donna Conna Ceiling

Photo 1.3 – Annex Building Room 42 - Donna Conna Ceiling

Photo 1.4 – Annex Building Room 42 attic - pink Fibreglass and Mineral Fibre Insulation.

Photo 1.5 - Annex Drywall Room 42

Photo 1.6 Building attic mineral fibre insulation bottom layer

Photo 1.7 Annex Ballast-suspected to contain PCB's

Photo 1.8 – Annex Room 42

Photo 1.9 - Annex Storage Rooms

Photo 1.10 – Annex Washroom-tiles contain asbestos

Photo 1.11 - Header House cement board lining inside heater-contains asbestos

Photo 1.12 – Inside lining contains asbestos.

Photo 1.13 Header House drywall joint compound contains asbestos

Photo 1.14 – Exterior board cement (no asbestos detected)

Photo 1.15 - Header House flooring

Photo 1.16 – Header House fumehood contains asbestos.

Photo 1.17 - Header House building heater

Photo 1.18 – Header House heating pipes H20 sampled, no asbestos detected.

Photo 1.19 Header House chemical storage H20

Photo 1.20 Smoke detector

Photo 1.21 - Typical Floor tiles-contains asbestos.

Photo 1.22 – H20 Valve insulation-sampled, no asbestos detected.

APPENDIX 3 Summary of Costs

Header House Building

Task	Description	Estimated Cost
1	Repair to damaged surfaces (walls and ceilings) with asbestos containing dry wall joint filler compounds.	Abatement Contractor $2,000
2	Moderate risk work by sprinkler contractors working on asbestos containing Dry wall Joint Filler Compounds in walls and ceilings.	Contractor $15,000 for additional materials, equipment and labour time
3	Encapsulate Fume hood in Room H8	Abatement Contractor $500
4	Clean and encapsulate Cement Wall Board within the perimeter Heater Casing in Rooms H3, H5, H6, H7, H8 and H9	Abatement Contractor $3,500

Annex Building

Task	Description	Estimated Cost
5	Repair to damaged surfaces (walls and ceilings) with asbestos containing dry wall joint filler compounds.	Abatement Contractor $2,000
6	Moderate risk work by sprinkler contractors working on asbestos containing Dry wall Joint Filler Compounds in walls and ceilings	Contractor $15,000 for additional materials, equipment and labour time
7	Mould was observed within Room 42	$5000 to contain, clean and dry area.

Hygiene Consulting Costs

Task	Description	Estimated Cost
8	Specifications and Tender Documents	$1500
9	Air Sampling and milestone inspections.	$2500
10	Asbestos Awareness and moderate risk work training to sprinkler contractors working on asbestos containing Dry wall Joint Filler Compounds in walls and ceilings.	Contractor Training $1,500
11	Mould abatement inspections and sampling and final report	$1,000

Appendix D

Preliminary Hazard Assessment Form

Public Works and Government Services Canada | Travaux publics et Services gouvernementaux Canada

PRELIMINARY HAZARD ASSESSMENT FORM

Project Number:	**R.076293.001**
Location:	**NRCAN - Pacific Forestry Center, Victoria**
Date:	July 12, 2016
Name of Departmental Representative:	Patrick Truong
Name of Client:	NRCAN
Name of Client Project Co-ordinator	Doug Moffat (250) 213-3457

Site Specific Orientation Provided at Project Location **Yes** ☐ **No** ☐

Notice of Project Required **Yes** ☐ **No** ☐

NOTE:
PWGSC REQUIRES A Notice of Project FOR ALL CONSTRUCTION WORK RELATED ACTIVITIES

NOTE:
OHS law is made up of many municipal, provincial, and federal acts, regulations, bylaws and codes. There are also many other pieces of legislation in British Columbia that impose OHS obligations.

Important Notice: This hazard assessment has been prepared by PWGSC for its own project planning process, and to inform the service provider of actual and potential hazards that may be encountered in performance of the work. PWGSC does not warrant the completeness or adequacy of this hazard assessment for the project and the paramount responsibility for project hazard assessment rests with the service provider.

TYPES OF HAZARDS TO CONSIDER	Potential Risk for:				COMMENTS
Examples: Chemical, Biological, Natural, Physical, and Ergonomic Listed below are common construction related hazards. Your project may include pre-existing hazards that are not listed. Contact the Regional Construction Safety Coordinator for assistance should this issue arise.	**PWGSC, OGD's, or tenants**		**General Public or other contractors**		Note: When thinking about this pre-construction hazard assessment, remember a **hazard** is anything that may cause harm, such as chemicals, electricity, working from heights, etc; the **risk** is the chance, high or low, that somebody could be harmed by these and other hazards, together with an indication of how serious the harm could be.
	Yes	**No**	**Yes**	**No**	
Typical Construction Hazards					
Concealed/Buried Services (electrical, gas, water, sewer etc)		X		X	
Slip Hazards or Unsound Footing		X		X	
Working at Heights		x		X	
Working Over or Around Water		x		X	
Heavy overhead lifting operations, mobile		x		X	

Canada

cranes etc.					
Marine and/or Vehicular Traffic (site vehicles, public vehicles, etc.		x		x	
Fire and Explosion Hazards		x		x	
High Noise Levels		x		x	
Excavations		x		x	
Blasting		x		x	
Construction Equipment		x		x	
Pedestrian Traffic (site personnel, tenants, visitors, public)	x			x	
Multiple Employer Worksite		X		X	Example: Contractor working in an occupied Federal Employee space.

Electrical Hazards					**Comments**
Contact With Overhead Wires		X		X	
Live Electrical Systems or Equipment	X		X		Lock out tagout proceducure need for electrical works
Other:					
Physical Hazards					
Equipment Slippage Due To Slopes/Ground Conditions		X		X	
Earthquake		X		X	
Tsunami		X		X	
Avalanche		X		X	
Forest Fires		X		X	
Fire and Explosion Hazards		X		X	
Working in Isolation		X		X	
Working Alone		X		X	
Violence in the Workplace		X		X	
High Noise Levels		X		X	
Inclement weather		X		X	
High Pressure Systems	X			X	Boilers and HWT
Other:					
Hazardous Work Environments					
Confined Spaces / Restricted Spaces		x		x	Review and provide confined space assessment(s) from PWGSC or client confined space inventories. Refer to PWGSC Standard on Entry into Confined Spaces. Contact the Regional Construction Safety Coordinator.
Suspended / Mobile Work Platforms		x		x	
Other:					
Biological Hazards					
Mould Proliferations		x		x	
Accumulation of Bird or Bat Guano		x		x	
Bacteria / Legionella in Cooling Towers / Process Water		x		x	

Rodent / Insect Infestation		x		x	
Poisonous Plants		x		x	
Sharp or Potentially Infectious Objects in Wastes		x		x	
Wildlife					
Chemical Hazards					
Asbestos Materials on Site		x		x	If "yes" a pre-project asbestos survey report is required. Provide Contractor with DP – 057 ELF Form 16 "Contractor Notification and Acknowledgement"
Designated Substance Present		x		x	If "yes" a pre-project designated substance survey report is required.
Chemicals Used in work		x		x	
Lead in paint		x		x	If "yes" a pre-project lead survey report is required.
Mercury in Thermostats or Switches		x		x	If "yes" a pre-project mercury survey report is required.
Application of Chemicals or Pesticides		x		x	
PCB Liquids in Electrical Equipment		x		x	
Radioactive Materials in Equipment		x		x	
Other:					
Contaminated Sites Hazards					
Hazardous Waste		x		x	
Hydrocarbons		x		x	
Metals		x		x	
Other:					

Security Hazards					**Comments**
Risk of Assault					
Other:					
Other Hazards					

Other Compliance and Permit Requirements[1]	**YES**	**NO**	**Notes / Comments**[2]
Is a Building Permit required?	**x**		
Is an Electrical permit required?	**x**		
Is a Plumbing Permit required?		**x**	
Is a Sewage Permit required?		**x**	
Is a Dumping Permit required?		**x**	
Is a Hot Work Permit required?	**X**		
Is a Permit to Work required?		**X**	Mandatory for ALL AFD managed work sites.
Is a Confined Space Entry Permit required?		**X**	Mandatory
Is a Confined Space Entry Log required		**X**	Mandatory for all Confined Spaces

Discharge Approval for treated water required		**x**	

Notes:

(1) Does not relieve Service Provider from complying with all applicable federal, provincial, and municipal laws and regulations.

(2) TBD means To Be Determined by Service Provider.

Service Provider Acknowledgement: We confirm receipt and review of this Pre-Project Hazard Assessment and acknowledge our responsibility for conducting our own assessment of project hazards, and taking all necessary protective measures (which may exceed those cited herein) for performance of the work.			
Service Provider Name	Public Works Services Canada		
Signatory for Service Provider		**Date Signed**	July 12, 2016
RETURN EXECUTED DOCUMENT TO PWGSC DEPARTMENTAL REPRESENTATIVE PRIOR TO ANY WORK COMMENCING			