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PROJECT MANUAL
Issued for Construction

Swift Current Research and Development Centre Phytotron Exhaust Modifications

Swift Current Sask.

2020-7-27

Contract No. 465-1-16-C44

Pages

Division 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

Division 01 - GENERAL REQUIREMENTS

Division 23 - Heating, Ventilating and Air Conditioning (HVAC)

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Division 26 - ELECTRICAL

List of Drawings

END OF SECTION

Part 1 General

Part 2 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises of the following works at the Swift Current Research and Development Centre, located in Swift Current, SK:

.2 The addition of a local exhaust system serving the growth chambers within the Phytotron. The work includes the installation of aluminum ductwork from the existing growth chambers, connected to an exhaust fan and exterior louvre. The manifolded ductwork system shall be properly air-balanced upon completion. The controls on the exhaust fan shall be tied to the existing BAS system. The existing AHU for the Phytotron shall be reprogrammed and balanced as directed upon completion of the project.

.3 All existing Growth Chambers are manufactured by Conviron. Conviron contact is Craig Leung Account Manager Conviron 590 Barry Street, Winnipeg MB R3H 0R9.

.4 Exhaust collars are to be Conviron Exhaust Assembly Collar with 23.6 L/s Air Regulator. Supplied by Conviron. Exhaust collars are to be installed to the satisfaction of Conviron and installation must be reviewed, inspected and approved by Conviron. See ME01for more details.

Part 3 CONTRACT METHOD

.1 Construct Work under single stipulated price contract.

Part 4 WORK SEQUENCE

.1 Construct Work in phases to accommodate use of premises, during construction.

.2 Continuous operation of the facility, with minimal shut down and impact to operations, is required.

.1 In the event interim accommodation for continued operation is required, include costs for interim accommodation and fit-up within the facility or external, at no additional cost to the Contract.

.3 Develop Construction Progress Schedule, taking into account continuous operation, and occupancy during construction.

.4 Maintain fire access/control.

Part 5 DEPARTMENTAL REPRESENTATIVE-FURNISHED ITEMS

.1 Departmental Representative’s Responsibilities:

.1 Inspect deliveries jointly with Contractor.

.2 Contractor's Responsibilities:

.1 Designate submittals and delivery date for each project in progress schedule.

.2 Review shop drawings, product data, samples, and other submittals. Submit to Departmental Representative notification of observed discrepancies or problems anticipated due to non-conformance with Contract Documents.

.3 Receive and unload products at site.

.4 Inspect deliveries jointly with Departmental Representative; record shortages, and damaged or defective items.

.5 Handle products at site, including uncrating and storage.

.6 Protect products from damage, and from exposure to elements.

.7 Assemble, install, connect, adjust, test, and finish products.

.8 Provide installation inspections required by public authorities.

.9 Repair or replace items damaged by Contractor or subcontractor on site (under its control).

Part 6 FIRE SAFETY REQUIREMENTS

.1 Comply with both the National Building Code of Canada 2010 and the National Fire Code of Canada 2010 for safety of persons in buildings in the event of a fire and the protection of buildings from the effects of fire, as follows;

.1 The National Building Code (NBC): for fire safety and fire protection features that are required to be incorporated in a building during construction.

.2 The National Fire Code (NFC):

.1 The on-going maintenance and use of the fire safety and fire protection features incorporated in buildings.

.2 The conduct of activities that might cause fire hazards in and around buildings.

.3 Limitations on hazardous contents in and around buildings.

.4 The establishment of fire safety plans.

.5 Fire safety at construction and demolition sites.

.2 Welding and cutting:

.1 At least one week prior to commencing cutting, welding or soldering procedure, provide to Departmental Representative:

.1 Notice of intent, indicating devices affected, time and duration of isolation or bypass.

.2 Completed welding permit as defined in NFC.

.3 Return welding permit to Departmental Representative immediately upon completion of procedures for which permit was issued.

.2 "Fire Watchers" as described in NFC shall be assigned when welding or cutting operations are carried out in areas where combustible materials within 15m may be ignited by conduction or radiation.

.3 Where work requires interruption or cause activation of fire alarms or fire suppression, extinguishing or protection systems:

.1 Provide "Watchman Service" as described in NFC; In general, watchman service is defined as an individual conversant with "Fire Emergency Procedures", performing fire picket duty within an unprotected and unoccupied (no workers) area once per hour.

.2 Retain services of manufacturer for fire protection systems on daily basis or as approved by Departmental Representative, to isolate and protect all devices relating to:

.1 modification of fire alarms, fire suppression, extinguishing or protection systems; and/or

.2 cutting, welding, soldering or other construction activities that might activate fire protection systems.

.3 Immediately upon completion of work, restore fire protection systems to normal operation and verify that all devices are fully operational.

.4 Inform fire alarm system monitoring agency and local Fire Department immediately prior to isolation and immediately upon restoration of normal operation.

Part 7 DOCUMENTS REQUIRED

.1 Maintain at job site, one copy 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 8 FIELD QUALITY CONTROL

.1 Carry out Work using qualified licensed workers or apprentices in accordance with Provincial Act respecting manpower vocational training and qualification.

.2 Permit employees registered in Provincial apprenticeship program to perform specific tasks only if under direct supervision of qualified licensed workers.

.3 Determine permitted activities and tasks by apprentices, based on level of training attended and demonstration of ability to perform specific duties.

.4 Provide Health and Safety requirements as per Saskatchewan Employment Act.

END OF SECTION

Part 1 General

1.1 CONTRACTOR USE OF PREMISES

.1 Refer to Section 01 52 00 – Construction Facilities, article “Access and Egress”.

.2 Limit use of premises for Work, for storage, and for access to allow:

.1 Departmental Representative occupancy of adjacent areas.

.2 Work by other contractors.

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

.4 Repair or replace portions of existing work which have been altered during construction.

.5 Closures: protect work temporarily until permanent enclosures are completed.

.6 Maintain life safety routes, and fire access/control.

.7 Ensure that Contractor personnel employed on site become familiar with and obey regulations including safety, fire, traffic, noise, and security regulations.

.8 Schedule delivery of materials during regular business hours, but outside of peak traffic times, unless otherwise approved by Departmental Representative.

1.2 BUILDING OCCUPANCY

.1 Refer to Drawings for phasing/work sequencing.

.2 Areas adjacent to the Work will remain occupied and in use as research laboratories during entire construction period for execution of normal operations.

.3 Disruption to building occupants in adjacent areas of the premises may impact on research in progress.

.4 Execute work with least possible interference or disturbance to building operations, occupants, and normal use of premises.

.5 Co-operate with Departmental Representative in scheduling operations to minimize conflict, to ensure research is not disturbed, and to facilitate continued Departmental Representative usage and operation.

.6 Protect infrastructure and services running through the area of the Work that supports occupied operational spaces.

.7 Work in Occupied Areas:

.1 Place sticky mat in area directly outside construction work zones in occupied areas, to trap dust from equipment and shoes of personnel leaving construction zone. Vacuum mat daily and when visibly soiled.

.2 Personnel shall wear clean coveralls, and booties over construction footwear. Personnel shall remove coveralls, and vacuum themselves with HEPA-filtered vacuum to remove dust from their clothing before leaving construction zone.

.3 Clean work area with HEPA-filtered vacuum at end of each work day.

.4 Cover and protect equipment and furnishings with clean tarpaulins.

.5 Seal doors, vents, and other sources of potential air leak between construction zone and adjacent occupied areas.

.6 Enclose supplies, equipment and waste in covered containers when transporting to and from occupied areas.

1.3 EXISTING SERVICES

.1 Notify Departmental Representative and utility companies of intended interruption of services. Obtain required permission 10 Working days in advance of interruption.

.2 Where Work involves interruption of services to occupied adjacent areas, breaking into or connecting to existing services, give Departmental Representative minimum two Working Days' notice for necessary interruption throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by Department Representative, or governing authorities with minimum disturbance to facility operations.

.3 Establish location and extent of service lines in area of work before starting Work. Notify Departmental Representative of findings.

.4 Submit schedule to and obtain approval from Departmental Representative for shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.

.5 Provide temporary services to maintain critical building systems, as directed by Departmental Representative.

.6 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.

.7 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.

.8 Record locations of maintained, re-routed and abandoned service lines.

1.4 BUILDING SMOKING POLICY

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

1.5 CONTROL OF NOISE, VIBRATION AND NOXIOUS FUMES AND SMOKE

.1 Be aware of locations of existing mechanical air intakes and vents. Prevent noxious fumes and smoke associated with the Work from entering surrounding occupied buildings.

.2 Minimize noise, vibration and dust-generating activities from affecting occupied areas. Provide 72 hours' notice to Departmental Representative prior to work causing noise, vibration, and dust generation. Schedule dust-generating work after normal work hours in and near occupied areas where it is not possible to isolate and contain the work.

.3 Be prepared to stop and reschedule Work upon verbal notice from Departmental Representative that the Work is causing detrimental effect on the operation of occupied areas. Such notice will only be made when specific procedures undertaken in occupied areas require it.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Action Submittals: Written and graphic information and physical samples that require Departmental Representative's responsive action. Unless specifically noted otherwise in individual sections, the following shall be considered Action Submittals:

.1 Product Data.
.2 Shop Drawings.
.3 Samples
.4 Construction Schedule.

.2 Informational Submittals: Written and graphic information and physical samples that do not require Departmental Representative's responsive action. Submittals may be rejected for not complying with requirements. Unless noted otherwise in individual sections, the following shall be considered Informational Submittals:

.1 Certificates.
.2 Maintenance Data.
.3 Test and Inspection Reports.
.4 Delegated Design Calculations.
.5 Closeout Submittals.
.6 Sample warranties.
.7 Sustainable design or LEED submittals.
.8 Manufacturer's installation instructions.

.3 Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.2 ADMINISTRATIVE

.1 Process submittals using electronic media. Provide submittals in electronic format, unless otherwise agreed to by Contractor and Departmental Representative.

.2 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.

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

.4 Present shop drawings, product data, in SI Metric units.

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

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

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

.8 Verify field measurements and affected adjacent Work are co-ordinated.

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

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

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

1.3 ELECTRONIC SUBMISSIONS

.1 Provide electronic submittals (excluding samples) for information and review in electronic format using the following guidelines:

.1 Provide in Portable Document Format (*.pdf) with selectable text and graphics that are readable. Generally, merge documents into one bookmarked document up to 10 mb. Use hierarchical bookmarks to form a table of contents and provide hyperlinks to the subject topic.

.2 Break down information into documents of “like” or related materials or systems.Include final ratings, parameters, specifications, options, and other pertinent information. In the case where Departmental Representative returns submittal “Approved As Noted” and includes mark-ups or comments that change originally submitted ratings, parameters, specifications, options, and other pertinent information, the Sub-Contractor shall correct the documents in the original electronic document prior to submitting the final electronic documents.

.3 Highlight specific rating, parameter, specification, option, and other pertinent information when original document includes multiple alternatives. For instance when a range of performance parameters are given, or various sizes are shown, or various options are listed, the applicable item shall be indicated by highlight, circle, or pointer.

.4 Do not include generalized direction from the Departmental Representative that does not relate to ordering and purchasing the equipment. For instance, notes like, “Coordinate with xxx for final motor horsepower” are not to be transferred to the electronic submittal. In that example only the final coordinated sizes would be indicated.

.5 References within this specification that indicate sheet size will refer to electronic sheet (printing) size.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures, product data, and other data which the Contractor provides to illustrate details of a portion of the Work.

.2 When requested for delegated-design, submit shop drawings bearing stamp and signature of qualified professional engineer registered or licensed in the Province of Saskatchewan.

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

.4 Departmental Representative will endeavour to review each submission within 10 Working Days.

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

.6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.Accompany submissions with transmittal letter, containing:

- .1 Date.
- .2 Project title and number.
- .3 Contractor's name and address.
- .4 Identification and quantity of each shop drawing, product data and sample.
- .5 Other pertinent data.

.7 Submissions include:

- .1 Date and revision dates.
- .2 Project title and number.
- .3 Name and address of Subcontractor, Supplier, and 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.
.11 Seal and signature of professional engineer if specified.

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

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

.10 Submit electronic copy of product data sheets or brochures for requirements requested in specification Sections where shop drawings will not be prepared due to standardized manufacture of product.

.11 Delete information not applicable to project.

.12 Supplement standard information to provide details applicable to project. If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copy 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.

.13 Review of shop drawings by Departmental Representative is for sole purpose of ascertaining conformance with general concept.

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

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

1.5 CONSTRUCTION SCHEDULE

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

.2 Provide necessary crews and manpower to meet schedule requirements for performing Work within specified Contract duration. Simultaneous use of multiple crews on multiple fronts on multiple critical paths may be required.

.3 Use experienced personnel, fully qualified in planning and scheduling to provide services from start of construction to Final Certificate, including Commissioning.

.4 Clearly show sequence and interdependence of construction activities and indicate:

.5 Start and completion of all items of Work, their major components, and interim milestone completion dates.

.6 Activities for procurement, delivery, installation and completion of each major piece of equipment, materials and other supplies, including:

.7 Time for submittals, resubmittals and review.

Time for fabrication and delivery of manufactured products for Work.

1.6 INFORMATIONAL SUBMITTALS

.1 Submit electronic copy of certificates for requirements requested in specification Sections.

.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.

.2 Submit electronic copy of manufacturers’ instructions for requirements requested in specification Sections.

.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.

.3 Submit electronic copy of Manufacturer's Field Reports for requirements requested in specification Sections.

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

END OF SECTION

Part 1 General

1.1 REFERENCES AND CODES

.1 Perform Work in accordance with the National Building Code of Canada (NBCC), the National Fire Code of Canada (NFC) and other codes of provincial or local application provided that in case of conflict or discrepancy, the most applicable requirements apply in accordance with the Authority Having Jurisdiction.

.2 Meet or exceed requirements of:

.1 National Building Code of Canada 2010

.2 National Fire Code of Canada 2010

.3 National Plumbing Code of Canada 2010.

.4 The Canadian Electrical Code.

.5 Specified standards, codes and referenced documents.

.6 CAN/CSA, Z462-08, Workplace Electrical Safety Standard

.7 Saskatchewan Employment Act for Health and Safety Requirements.

.3 Electrical components and equipment which are not CSA approved shall be approved by the Authority Having Jurisdiction prior to connection to the electrical service. Pay for costs associated with obtaining necessary approval.

1.2 PERMITS AND BY-LAWS

.1 Submit applications, documents and obtain and pay for permits and certificates required in respect to the execution of the Work.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 Product Testing: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL), a national voluntary laboratory accreditation program (NVLAP), or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

.2 Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

.3 Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

.4 Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.2 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, or law of Place of Work. Coordinate date and time with regularly scheduled site visits performed by Departmental Representative.

.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.

.5 Conviron is to be engaged to perform Quality Control inspections on the installation of the exhaust collars. Conviron contact is Craig Leung Account Manager Conviron 590 Barry Street, Winnipeg MB R3H 0R9.

1.3 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies may be engaged by Departmental Representative for purpose of inspecting or testing portions of Work, for quality assurance purposes.

.2 Employment of inspection and testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.

.3 If defects are revealed during inspection or testing, appointed agency will request additional inspection or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and reinspection.

1.4 CONTRACTOR'S RESPONSIBILITIES

.1 Tests and inspections not explicitly assigned to the Departmental Representative are the Contractor's responsibility.

.2 Include cost of tests and inspection in Contract Price.

.3 Provide labour, equipment and facilities to:

.1 Provide access to work to be inspected and tested.

.2 Facilitate inspections and tests.

.3 Make good work disturbed by inspection and test.

.4 Provide storage on site for laboratory's exclusive use to store equipment and cure test samples.

.4 Notify Departmental Representative sufficiently in advance of operations to allow for assignment of laboratory personnel and scheduling of test.

.5 Where materials are specified to be tested, deliver representative samples previously reviewed by Departmental Representative in required quantity to testing laboratory.

.6 Pay costs for uncovering and making good work that is covered before required inspection or testing is completed and reviewed by Departmental Representative.

.7 Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 – Submittals.

.8 Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

1.5 ACCESS TO WORK

.1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.

.2 Co-operate to provide reasonable facilities for such access.

1.6 PROCEDURES

.1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.

.2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.

.3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.7 REJECTED WORK

.1 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, Departmental Representative 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.

1.8 REPORTS

.1 Submit electronic copy of inspection and test reports to Departmental Representative, in accordance with Section 01 33 00 – Submittal Procedures.

.2 Submit reports within one week of testing or inspection.

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

.4 Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

.1 Date of issue.

.2 Project title and number.

.3 Name, address, and telephone number of testing agency.

.4 Dates and locations of samples and tests or inspections.

.5 Names of individuals making tests and inspections.

.6 Description of the Work and test and inspection method.

.7 Identification of product and Specification Section.

.8 Complete test or inspection data.

.9 Test and inspection results and an interpretation of test results.

.10 Record of temperature and weather conditions at time of sample taking and testing and inspecting.

.11 Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.

.12 Name and signature of laboratory inspector.

.13 Recommendations on retesting and reinspecting.

.5 Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

.1 Name, address, and telephone number of technical representative making report.

.2 Statement on condition of substrates and their acceptability for installation of product.

.3 Statement that products at Project site comply with requirements.

.4 Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.

.5 Results of operational and other tests and a statement of whether observed performance complies with requirements.

.6 Statement whether conditions, products, and installation will affect warranty.

.7 Other required items indicated in individual Specification Sections.

.6 Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

.1 Name, address, and telephone number of factory-authorized service representative making report.

.2 Statement that equipment complies with requirements.

.3 Results of operational and other tests and a statement of whether observed performance complies with requirements.

.4 Statement whether conditions, products, and installation will affect warranty.

.5 Other required items indicated in individual Specification Sections.

.7 Permits, Licenses, and Certificates: For Departmental Representative’s records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 TEST AND INSPECTION LOG

.1 Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

.1 Date test or inspection was conducted.

.2 Description of the Work tested or inspected.

.3 Date test or inspection results were transmitted to Departmental Representative.

.4 Identification of testing agency or special inspector conducting test or inspection.

.2 Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Departmental Representative's reference during normal working hours.

1.10 REPAIR AND PROTECTION

.1 General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

.1 Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

.2 Protect construction exposed by or for quality-control service activities.

.3 Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Province of Saskatchewan

.1 The Occupational Health and Safety Act, 1993 (including amendments effective November 7, 2012)

.2 The Occupational Health and Safety Regulations, 1996

1.2 SUBMITTALS

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

.2 Informational Submittal: Submit design drawings, signed and sealed by qualified professional engineer licensed in the province of Saskatchewan, for scaffolds and work platforms, in accordance with Section 01 33 00 – Submittal Procedures.

.1 Additions or modifications to scaffolding must be approved by professional engineer in writing.

1.3 ACCESS AND EGRESS

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

.2 Limit access to and egress from the construction site by way of access gate designated by Departmental Representative.

.3 Provide additional temporary access facilities as required. Design, construct and maintain temporary access facilities, including but not necessarily limited to stairs, runways, ramps, ladders and scaffolding, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations, and without negative effect on operating areas of the facility.

.4 In the event temporary openings are required in exterior walls, ensure openings are weathertight, and vermin proof. Reinstate exterior walls to condition that existed prior to construction.

.5 Maintain safe occupant access, egress and internal circulation for occupied areas of the buildings, and for construction workers in the area of the Work.

.1 Ensure Authorities Having Jurisdiction review and approve egress routes. Do not alter egress routes without prior approval from Authorities Having Jurisdiction.

.2 Post egress routes as part of emergency procedures.

1.4 SCAFFOLDING

.1 Scaffolding: in accordance with Province of Saskatchewan, The Occupational Health and Safety Act, 1993, and The Occupational Health and Safety Regulations.

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

.3 Erect without damage to building or finishes scheduled to remain.

1.5 HOISTING

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

.2 Hoists and cranes: operated by qualified operator.

.3 Locate hoists and cranes in location approved by Departmental Representative.

1.6 USE OF SITE AND FACILITIES AND SITE STORAGE

.1 Construction staging area will be assigned to the Contractor for storage of construction materials. Maintain in neat condition.

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

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

.4 Move stored products or equipment that interfere with operations of Departmental Representative or other contractors.

.5 Obtain and pay for use of additional storage or work areas needed for operations.

1.7 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.

1.8 CONSTRUCTION PARKING

.1 Limited parking may be permitted on site within designated staging area at the discretion of the Departmental Representative.

.2 Limited parking for construction personnel vehicles may be available in adjacent parking areas at prevailing rates. Make own arrangements for parking.

.3 Provide and maintain adequate access to project site.

1.9 SECURITY

.1 Contractor must have all employees on site to be Security Cleared.

1.10 SANITARY FACILITIES

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

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

1.11 CLEAN-UP

.1 Refer to section 1.73.11

END OF SECTION

Part 1 General

1.1 GENERAL PROJECT CLEANLINESS

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

.2 Remove waste materials from site minimum once daily at regularly scheduled times.. Remove waste materials more frequently as directed by Departmental Representative. Do not burn waste materials on site.

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

.4 Dispose of waste materials and debris off site. Do not wash waste materials down sewers or into waterways.

.5 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

.6 Do not damage or soil existing waste handling and housekeeping rooms. Do not plug or obstruct hoppers, toilets, sinks or drains.

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

.8 Schedule cleaning operations so that resulting dust and other contaminants will not fall on wet, newly painted surfaces, infiltrate into occupied areas, or trigger fire alarm smoke or dust detectors.

1.2 PROGRESSIVE CLEANING

.1 Remove liquid spills promptly.

.2 Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

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

.4 Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

.5 Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

.6 Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Performance.

.7 In occupied areas, clean-up work area each day, before leaving area. Vacuum area with HEPA vacuum and leave ready for use.

.8 During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Performance.

.9 Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

.10 Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

1.3 FINAL CLEANING

.1 In preparation for Substantial Performance or occupancy, conduct inspection of sight-exposed surfaces.

.2 Remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.

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

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

.5 Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials, from sight-exposed interior and exterior finished surfaces.

.6 Vacuum clean and dust building interiors, behind grilles, louvres and screens in area of Work. Vacuum exterior surfaces of exposed ductwork.

.7 Remove dirt and other disfiguration from exterior surfaces.

1.4 SITE RESTORATION

.1 Upon completion of project, reinstate surfaces and building or site finishes affected by Work to condition which existed prior to commencement of Work, unless directed otherwise.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Acceptance of Work Procedures:

.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 that corrections have been made.

.2 Request Departmental Representative's Inspection.

.2 Departmental Representative's Interim Completion Inspection:

.1 Departmental Representative¸ and Contractor will perform inspection of Work to identify defects or deficiencies.

.2 Contractor shall correct Work as directed. Coordinate with Departmental Representative to establish a date for completion of deficiencies.

.3 Completion Tasks: submit written certificates in English that the following tasks have been performed:

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

.2 Defects: corrected and deficiencies completed.

.3 Equipment and systems: tested, adjusted, and balanced, and fully operational.

.4 Certificates required by authorities having jurisdiction: submitted.

.5 Operation of systems: demonstrated to facility personnel.

.6 Commissioning of building systems and laboratory equipment: completed in accordance with 01 91 13 - General Commissioning (Cx) Requirements, and technical specifications. Copy of final Commissioning Report submitted to Departmental Representative.

.2 Prior to Interim Completion of the Work, or start of operation and instruction period, whichever is earlier, provide:

.1 Draft Operation and Maintenance Manuals for mechanical systems, electrical systems, and laboratory equipment prior to start up for reference purposes.

.2 Record and "as-built" drawings.

.3 Keys for equipment and building as specified, including related keying information and keying charts.

.4 Test reports for mechanical and electrical systems, as specified in Divisions, , 23 25, , and 26.

.5 Equipment and systems operating instructions and orientation for facility personnel.

.6 Spare parts.

.7 Warranty and Bond Certificates.

.8 Commissioning and Commissioning Reports.

.3 Final Inspection:

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

.2 If Work is deemed incomplete by Departmental Representative, complete outstanding items and request re-inspection.

.4 Declaration of Interim Completion: when Departmental Representative advises Contractor that deficiencies and defects have been corrected and it appears requirements of Contract have been substantially performed, make application for certificate of Interim Completion.

.5 Commencement of Warranty Periods: date of Departmental Representative's acceptance of submitted declaration of Interim Completion shall be date for commencement for warranty period.

.6 Final Payment:

.1 When Departmental Representative considers final deficiencies and defects have been corrected and it appears requirements of Contract have been totally performed, make application for final payment.

.2 If Work is deemed incomplete by Departmental Representative, complete outstanding items and request reinspection.

.7 Payment of Holdback: after issuance of certificate of Interim Completion of the Work, submit an application for payment of holdback amount in accordance with General Conditions.

1.2 FINAL CLEANING

.1 In accordance with Section 01 74 11 – Cleaning.

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 01 91 13 requirements for General Commissioning

.2 01 91 33 requirements for Commissioning Forms

.3 01 91 41 requirements for Commissioning Training

1.2 REFERENCES

.1 Public Works and Government Services Canada (PWGSC)

.1 PWGSC - Commissioning Guidelines CP.4 -3rd edition-[03].

.2 Underwriters' Laboratories of Canada (ULC)

.3 Commissioning Plan developed by the Departmental Representative has been attached to these specifications and clearly defines the commissioning process. Refer to Commissioning Plan, contained in Volume 4 – Appendices, of the Project Manual.

1.3 GENERAL

.1 Provide a fully functional facility

.1 Systems, subsystems, integrated systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.

.2 Facility user and O M personnel have been fully trained in aspects of installed systems.

.3 Optimized life cycle costs.

.4 Complete documentation relating to installed equipment and systems.

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

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

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

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

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

.4 Describes process of verification of how built works meet the owner’s project requirements

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

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

.1 Overview of Cx.

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

.3 Process and methodology for successful Cx.

.4 Acronyms:

.1 Cx - Commissioning.

.2 BMM - Building Management Manual.

.3 EMCS - Energy Monitoring and Control Systems.

.4 MSDS - Material Safety Data Sheets.

.5 PI - Product Information.

.6 PV - Performance Verification.

.7 IVC – Installation Verification Checklist

.8 FPT – Functional Performance Testing

.9 TAB - Testing, Adjusting and Balancing.

.10 WHMIS - Workplace Hazardous Materials Information System.

.5 Commissioning terms used in this Section:

.1 Bumping: short term start-up to prove ability to start and prove correct rotation.

.2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

.1 Assist the Departmental Representative in providing information required to complete this plan.

1.5 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

.1 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.

.2 Departmental Representative will select Cx Team consisting of following members:

.1 PWGSC Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.

.2 PWGSC Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:

.1 Review of Cx documentation from operational perspective.

.2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.

.3 Protection of health, safety and comfort of occupants and O M personnel.

.3 Departmental Representative is responsible for:

.1 Organizing Cx.

.2 Creating and approving Installation Verification Forms, Start-up Forms and Functional Performance Testing Forms

.3 Witnessing, certifying accuracy of reported results.

.4 Witnessing and certifying TAB and other tests.

.5 Witnessing functional performance testing of of installed equipment, subsystems, systems and integrated systems

.6 Reviewing Operation and Maintenance Manuals provided by the contractor

.7 Reviewing owner/operator training plan

.8 Providing final commissioning report

.9 Work closely with members of Cx Team.

.4 Construction Team: Contractor is responsible for construction/installation in accordance with contract documents, approved shop drawings & product data, approved changes to contract and subcontractor's & suppliers requirements, including:

.1 Testing.

.2 TAB.

.3 Performance of Cx activities.

.4 Delivery of training and Cx documentation.

.5 Assigning one person as point of contact with Departmental Representative for administrative and coordination purposes.

.5 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:

.1 Day-To-Day operation and maintenance of facility.

1.6 CX PARTICIPANTS

.1 Employ the following Cx participants to verify performance of equipment and systems:

.1 Installation contractor/subcontractor:

.1 Equipment and systems except as noted.

.2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.

.1 To include performance verification.

.3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.

.4 Specialist Cx agency:

.1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.

.5 Ensure that Cx participant:

.1 Could complete work within scheduled time frame.

.2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O M personnel, including:

.1 Modify ventilation rates to meet changes in off-gassing.

.2 Changes to heating or cooling loads beyond scope of EMCS.

.3 Changes to EMCS control strategies beyond level of training provided to O M personnel.

.4 Redistribution of electrical services.

.5 Modifications of fire alarm systems.

.6 Modifications to voice communications systems.

.6 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Functional Performance Testing for review and approval.

1.7 EXTENT OF CX

.1 Commission mechanical systems and associated equipment.

.1 HVAC and exhaust systems:

.1 New exhaust fan and ductwork for dedicated Phytotron exhaust

.2 Modified Phytotron air handling unit

.2 EMCS

.1 Controls associated with new exhaust fan and modifications to existing air handling unit controls.

.2 Commission electrical systems and equipment:

.1 Electrical distribution system:

.1 Electrical power connections to new mechanical equipment.

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.

1.9 DELIVERABLES RELATING TO THE CX PROCESS

.1 General:

.1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.

.2 Definitions:

.1 Cx as used in this section includes:

.1 Cx of components, equipment, systems, subsystems, and integrated systems.

.2 Factory inspections and performance verification tests.

.3 Deliverables: provide:

.1 Completed installation verification checklists (IVC).

.2 Completed equipment start-up forms

.3 Description of Cx of integrated systems and documentation.

.4 Training Plans.

.5 Prescribed activities during warranty period.

1.10 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Items listed in this Cx Plan include the following:

.1 Conduct Installation Verification and Start-up: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and does not form part of Cx specifications.

.2 Departmental Representative will monitor some of these inspections and tests.

.3 Submit completed documentation to the Departmental Representative.

.2 Pre-Cx activities - MECHANICAL:

.1 Plumbing systems:

.1 "Bump" each item of equipment in its "stand-alone" mode.

.2 Complete installation verification and start-up checklists.

.3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

.2 HVAC equipment and systems:

.1 "Bump" each item of equipment in its "stand-alone" mode.

.2 At this time, complete installation verification checklists

.3 Coordinate start-up after installation verification checklists have been submitted and approved.

.4 Complete start-up report. Supplement start-up reports as required with manufacturer's start-up report.

.5 After equipment has been started, operate equipment for functional testing in conjunction with control systems on a system-by-system basis.

.6 Perform TAB on systems. TAB reports to be approved by Departmental Representative

.3 EMCS:

.1 EMCS trending to be available as supporting documentation for functional performance testing.

.2 Perform point-by-point testing in parallel with start-up.

.3 Submit point-by-point testing results to Departmental Representative

.4 Carry out point-by-point verification.

.5 Operate systems for functional testing as directed by the Departmental Representative

.6 Perform final Cx and operational tests during demonstration period and 30 day test period.

.7 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".

.3 Pre-Cx activities - ELECTRICAL:

.1 Electrical Distribution Equipment

.1 Complete installation verification and start-up forms and submit to the Departmental representative for review and approval.

.2 Allow time to test and demonstrate system to Departmental Representative.

.2 Uninterruptible Power Supply (UPS)

.1 Complete installation verification and start-up forms and submit to the Departmental representative for review and approval.

.2 Allow time to test and demonstrate system to Departmental Representative.

.3 Conform to testing requirements outlined in Section 26 33 53.

.4 Operate equipment as required for functional testing.

1.11 START-UP

.1 Start up components, equipment and systems.

.2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's directions all commissioned equipment

.3 Departmental Representative to monitor some of these start-up activities.

.1 Rectify start-up deficiencies to satisfaction of Departmental Representative.

.4 Contractor to provide complete start-up forms to Departmental Representative for review and approval.

1.12 FUNCTIONAL PERFORMANCE TESTING

.1 Functional performance testing to commence once installation verification and start-up forms have been reviewed and approved.

.2 Functional performance testing forms to be developed by Departmental Representative.

.3 Contractor to operate equipment as required for all functional performance testing.

.4 Departmental Representative will witness functional performance testing and record results.

1.13 INSTALLATION VERIFICATION CHECK LISTS (IVC)

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists, Start-up and Functional Performance Testing Forms.

1.14 EQUIPMENT START-UP FORMS

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists, Start-up and Functional Performance Testing Forms.

1.15 FUNCTIONAL PERFORMANCE TESTING FORMS

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists, Start-up and Functional Performance Testing Forms.

1.16 DELIVERABLES RELATING TO ADMINISTRATION OF CX

.1 General:

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

1.17 CX SCHEDULES

.1 Prepare detailed critical path Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:

.1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:

.1 Design criteria, design intents.

.2 Building envelope related mock-ups and testing.

.3 Pre-TAB review: 28 days after contract award, and before construction starts.

.4 Submission of list of instrumentation with relevant certificates: 21 days before start of Functional Testing.

.5 Notification of intention to start TAB: 21 days before start of TAB.

.6 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.

.7 Notification of intention to start Functional Performance Testing: 14 days before start of Functional Performance Testing.

.8 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed and 14 days before start of integrated system Cx.

.9 Identification of deferred Cx.

.10 Implementation of training plans.

.2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.

.3 Scheduling is to take into account the phasing of this project. Commissioning activities are to be scheduled such that systems required for each phase are fully tested and operational prior to the occupancy of the respective construction phase. This will result in staggering commissioning activities as different areas become ready for commissioning.

.4 6 months in Cx schedule for verification of performance in all seasons and weather conditions.

.2 After approval, incorporate Cx Schedule into Construction Schedule.

.3 Monitor progress of Cx against this schedule.

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 systems.

.2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.

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 Departmental Representative, lock control devices in their final positions.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 GENERAL

1.1 SUMMARY

.1 Section Includes:

.1 Commissioning forms to be completed for equipment, systems and integrated systems.

.2 Related Requirements

.1 Section 01 91 13 GENERAL COMMISSIONING (CX) REQUIREMENTS

.2 Section 01 91 31 COMMISSIONING (CX) PLAN

.3 Section 01 91 41 COMMISSIONING TRAINING

1.2 INSTALLATION VERIFICATION/START-UP CHECK LISTS

.1 Complete Installation Verification and Start-up forms provided by the Departmental Representative.

.2 Forms will include the following data:

.1 Equipment nameplate data.

.2 Product manufacturer's installation instructions and recommended checks.

.3 Special procedures as specified in relevant technical sections.

.4 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.

.5 Complete start-up data verifying proper performance of the individual pieces of equipment

.3 Equipment manufacturer's installation/start-up check lists may be acceptable for use. Submit these forms to the Departmental Representative for approval prior to use.

.4 Use Installation Verification Checklists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.

.5 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to the Departmental Representative. Departmental Representative will spot check the completed check lists on site and approve. Check lists will be required during functional testing and will be included in Commissioning Report at completion of project.

.6 Refer to the sample forms provided at the end of this specification

1.3 FUNCTIONAL PERFORMANCE TESTING (FPT) FORMS

.1 FPT 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 FPT report forms are developed by the Departmental Representative.

.3 Assist in the development of FPT forms where required.

.4 Operate equipment for all systems and integrated systems for functional performance testing witnessed by the Departmental Representative.

.5 Forms are completed by the Departmental Representative.

.6 Refer to sample forms provided at the end of this specification

1.4 SAMPLES OF COMMISSIONING FORMS

.1 Required commissioning forms will be provided by the Departmental Representative.

.2 Revise items on Commissioning forms as required to suit project requirements.

.3 Samples of Commissioning forms are provided at the end of this specification.

1.5 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

.1 When additional forms are required, but are not available from Departmental Representative, develop appropriate verification forms and submit to Departmental Representative for approval prior to use.

.1 Additional commissioning forms to be in same format as provided by Departmental Representative.

1.6 COMMISSIONING FORMS

.1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.

.2 Strategy for Use:

.1 Contractor will be provided with project-specific commissioning forms.

.2 Contractor to complete IVC and Start-up forms and verify correct installation and operation of items indicated on these forms.

.3 Confirm operation as per design criteria and intent.

.4 Identify variances between design and operation and reasons for variances.

.5 Verify operation in specified normal and emergency modes and under specified load conditions.

.6 Record analytical and substantiating data.

.7 Verify reported results.

.8 Form to bear signatures of recording technician and reviewed and signed off by Departmental Representative

.9 Submit immediately after tests are performed.

.10 Reported results in true measured SI unit values.

.11 Provide Departmental Representative with originals of completed forms.

.12 Maintain copy on site during start-up, testing and commissioning period.

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 Section 01 91 13 GENERAL COMMISSIONING (CX) REQUIREMENTS.

.2 Section 01 91 31 COMMISSIONING (CX) PLAN

.3 Section 01 91 33 COMMISSIONING 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.

1.3 INSTRUCTORS

.1 Departmental Representative 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 for normal, abnormal and emergency situations.

.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.

1.4 TRAINING OBJECTIVES

.1 Training to be detailed and 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 Contractor 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 FPT Reports.

.3 Departmental Representative 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 Multimedia presentations.

.2 Manufacturer's training videos.

.3 Equipment models.

1.6 SCHEDULING

.1 Include in Commissioning Schedule time for training.

.2 Deliver training during regular working hours.

.3 Each training session is to be a maximum of 3 hours in length.

.4 Training to be completed prior to acceptance of facility.

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, witnessed by Departmental Representative.

1.8 TRAINING CONTENT

.1 Training to include demonstrations by Instructors using the installed equipment and systems.

.2 Content includes:

.1 Review of facility and occupancy profile.

.2 Functional requirements.

.3 System philosophy, limitations of systems and emergency procedures.

.4 Review of system layout, equipment, components and controls.

.5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures for normal, abnormal and emergency situations.

.6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.

.7 Maintenance and servicing.

.8 Trouble-shooting diagnosis.

.9 Inter-Action among systems during integrated operation.

.10 Review of O M documentation.

.3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

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.

.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 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Saskatchewan, Canada where specified.

.2 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

.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.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

.1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.3 Maintenance data to include:

.1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required and task time.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.5 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Make changes as required and re-submit as directed by Departmental Representative.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 Departmental Representative 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. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.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.

.8 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 Departmental Representative 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.

.9 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittals.

.2 Furnish spare parts as follows:

.1 One set of belts for exhaust fans.

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

.4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

.1 Not used.

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 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 PAINTING REPAIRS AND RESTORATION

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

.2 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.4 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 - ACTION AND INFORMATIONAL 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 - ACTION AND INFORMATIONAL 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 Refer to section 23 05 03 – Acceptable HVAC Manufacturers for QA/QC requirements associated with the growth chambers.

3.5 DEMONSTRATION

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

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

.1 Phytotron growth chamber exhaust system.

.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.

.6 Departmental Representative will record these demonstrations on video tape for future reference.

3.6 PROTECTION

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

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Refer to Section 23 05 00 – Common Work Results for HVAC.

1.2 SELECTIONS

.1 With the exception of the exhaust collars described in Part 2, any product is accepted for installation in the work, provided the product chosen meets with the required design characteristics as particularly noted in the specifications and equipment schedules, and matches the design features of the item where a particular trade name and model is given, and suits the installation. Conform to space limitations on products that are equal in design characteristics.

1.3 CHANGES DUE TO USE OF DIFFERENT MANUFACTURERS

.1 Where the Contractor proposes to use an item of equipment other than that detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or of any other part of the mechanical, electrical or architectural layout, all such redesign and all new Drawings and details required shall, with the acceptance of the Departmental Representative, be prepared by the Contractor at his own expense.

.2 Where deviations are accepted requiring a different quantity or arrangement of ductwork, piping, wiring, conduit and equipment from that indicated on the Drawings, this Division is responsible to furnish and install all such ductwork piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, without additional compensation.

1.4 SHOP DRAWINGS

.1 Submit shop drawings for all mechanical items.

Part 2 Products

.1 Growth chamber exhaust collars

.1 Growth chamber exhaust collars shall be provided by Conviron. Substituations will not be accepted. The contractor shall include costs for Conviron to inspect the exhaust collar installation to ensure collars are installed to their specifications. At the contractors' option, Conviron may be hired to install the exhaust collars.

Part 3 Execution

.1 Not used.

□

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Canadian Standards Association (CSA)

.1 CSA C22.2 NO. 100-04, Motors and Generators, Includes Update No. 1, Update No. 2, Update No. 3.

.2 CSA C747-09, Energy efficiency test methods for small motors

.3 CSA C390-10, Test methods, marking requirements, and energy efficiency levels for three-phase induction motors

1.2 SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

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

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Division 01

Part 2 Products

2.1 GENERAL

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

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 Comply with all Canadian Electrical Code requirements, and in particular CSA C22.2 No. 100, c/w CSA label, unless otherwise specified.

.3 Motors included in the scope of CAN/CSA-C747 shall have a nominal full-load efficiency not less than the minimum specified in that standard. Efficiency ratings of motors included in the scope of this standard shall be based on a statistically valid quality control procedure conforming to the standard. Nameplates shall list the nominal full-load motor efficiency.

.4 Motors included in the scope of CAN/CSA-C390 shall have a nominal full-load efficiency not less than the minimum specified in that standard. Efficiency ratings of motors included in the scope of this standard shall be based on a statistically valid quality control procedure conforming to the standard. Nameplates shall list the nominal full-load motor efficiency.

.5 In general, motors are EEMAC Class B (for standard torque applications), 1,800 RPM, continuous duty, open drip proof, ball bearing, 40ºC temperature rise above 40ºC ambient, 1.15 service factor. Motors are squirrel cage induction unless specifically noted otherwise. Special motors are specified with the equipment driven.

.6 Single-phase motors shall be equipped with integral thermal overload protection.

.7 Provide adequate capacity on each motor to operate the associated driven device under all conditions of load and service without overloading and be of at least the power specified.

.8 Refer to Division 26 and provide motor characteristics within +5% of power source, or get written approval from the Departmental Representative.

.9 Co-operate with Division 26 during start-up and provide all necessary assistance during commissioning.

.10 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

2.3 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.

.3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified rpm.

.4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave to be determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

.8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.4 GUARDS

.1 Provide guards for all drives as specified and required by Authorities Having Jurisdiction.

.2 Guards for belt drives (minimum requirements):

- .1 Expanded galvanized metal screen welded to galvanized steel frame.
- .2 Minimum 1.2 mm thick galvanized sheet metal tops and bottoms.
- .3 Prime coat for painting.
- .4 38 mm diameter holes on both shaft centres for insertion of tachometer.
- .5 Allow movement of motors for adjusting belt tension.

.3 Guards for flexible couplings (minimum requirements):

- .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
- .2 Prime coat for painting.

.4 Guards are to be readily removable to permit servicing of equipment.

.5 Provide means to permit lubrication and use of test instruments with guards in place.

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 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 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.

1.2 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 11 - Cleaning

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, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

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

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5.

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

2.3 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.4 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system data where applicable including point name and ID number, equipment type, setpoint and range, function and (where appropriate) fail-safe position.

.2 Provide printed cards, laminated with heavy plastic both side, and secure using nylon ties.

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

2.5 LANGUAGE

.1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

3.3 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.4 LOCATION OF IDENTIFICATION ON 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

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

.3 National Building Code of Canada (NBC) 2010.

1.2 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 professional engineer registered or licensed in Province of Saskatchewan, Canada where specified.

.2 Provide separate shop drawings for each isolated system complete with performance and product data.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

.3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 11 - Cleaning.

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 H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.3 Performance: as recommended by ASHRAE.

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 vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.2 Ensure 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.

.3 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.

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 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 SCHEDULE

.1 Refer to following schedule. Follow manufacturer’s recommendations where they differ from requirements below.

Item	Isolator Type
Suspended Centrifugal Fans	Type H2

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Testing, adjusting and balancing (TAB) is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 SCOPE OF TAB

.1 TAB for this project consists of balancing of the new growth chamber exhaust system as well as a measurement and adjustment of AHU-PHYTO to ensure design airflows are maintained on the supply and return.

1.3 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Departmental Representative within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.5 CO-ORDINATION

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

1.6 PRE-TAB REVIEW

.1 Review contract documents and submit documentation specified below in writing to the Departmental Representative prior to the installation of any systems that will require TAB.

.2 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB. Note any inadequacies that may require attention.

.3 Submit to the Departmental Representative a written description of approach to TAB for each system, written specifically for the project, outlining sequence and procedures for the work. Include relevant information including, but not limited to, location of main duct traverses, approach to optimizing system setpoints, concerns affecting other trades such as weatherstripping and penetration sealing, and possible limitations of specified equipment and design that may affect TAB. Identify deviations in methodology from referenced standards and commonly accepted industry practice.

.4 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

.5 Review proposed location of sensors and test ports with other trades to confirm that locations are suitable for TAB equipment and will permit repeatable measurements to permit recalibration on HVAC controls sensors.

.6 Review location of balancing dampers and control valves for adequacy with respect to successful TAB completion.

.7 Confirm in writing to Departmental Representative adequacy of provisions for TAB, noting

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Pressure, leakage, other tests specified elsewhere Division 23.

.3 Provisions for TAB installed and operational.

.4 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

1.9 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 Air systems: plus or minus 5% of the quantities shown on the drawings for each component, and to within 5% of design requirements for the overall system.

1.10 ACCURACY TOLERANCES

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

1.11 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.12 SUBMITTALS

.1 Submit, prior to commencement of TAB:

.1 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.13 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Departmental Representative prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.
.2 Details of TAB procedures employed.
.3 Calculations procedures.
.4 Summaries.

1.14 TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.
.2 System schematics.

.3 Submit 1 electronic copy of TAB Report to Departmental Representative for verification and approval.

1.15 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30 % of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.16 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, return systems and equipment to final operation condition. Replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Markings shall not be covered in anyway and shall be permanent and not easily eradicated.

.1 Mark position of balancing dampers using permanent pen, indicating position of damper handle on duct or quadrant.

1.17 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.18 INSTRUMENT TEST PORTS AND HOLES

.1 Coordinate test openings with Division 23.

.2 Utilize permanent test ports where installed by Division 23.

.3 Where permanent test ports are not installed, make openings as required to facilitate the TAB. Seal test port openings in ductwork using rubber plugs or material with similar properties, which are not easily removed. Hard or semi-flexible plugs such as nylon or polyethylene will not be accepted. Submit samples for each side to the Departmental Representative for approval prior to installation. Alternately, patch ductwork using sheet metal patch screwed to duct and seal with aluminum tape or duct sealant.

1.19 DRIVE CHANGES FOR BELT DRIVEN EQUIPMENT

.1 Allow for drive changes on all belt driven equipment.

.1 Include sheaves and bushings for driver and driven equipment, belts and other equipment and tools necessary to make drive change.

.2 Include all manpower necessary to make drive change, including removal and reinstallation of guards.

1.20 AIR SYSTEMS

.1 Standard: TAB to be to most stringent of this section or TAB standards of AABC or NEBB.

.2 Do TAB of systems, equipment, components, controls specified in Division 23.

.3 Qualifications: personnel performing TAB to be current member in good standing of AABC or NEBB.

.4 Quality assurance: Perform TAB under direction of supervisor qualified by standards of AABC or NEBB.

.5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, and controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, current draw, noise, vibration.

.6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, heat exchangers, other equipment causing changes in conditions.

.7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

.8 Measure and record outside ambient conditions at time of test and include data in the report. Measure ambient conditions at time of start of TAB for each system.

.9 Assist the controls sub-trade in adjusting/calibrating filter differential pressure sensors for the recommended change-out setpoint.

1.21 VERIFICATION OF CONTROLS SYSTEMS

.1 TAB Contractor shall assist in verification, demonstration and calibration of the HVAC controls systems, specified under Division 23 and/or 25.

1.22 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

.1 Qualifications of TAB personnel: as for air systems specified this section.

.2 Quality assurance: as for air systems specified this section.

.2 Building pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

.2 Measure and report on building pressure during different operating mode and at various quantities of outside air. Report measurements at different percentages of outside based on total system air volumes, in increment of 10%. Perform measurements when all systems are in normal operating modes.

1.23 SCHEDULE

.1 Schedule the balancing to suit the progress of the work. Make every attempt to complete the work, or at least the affected local work, prior to occupancy or partial occupancy.

.2 In phased projects, complete the work in each phase, as it is completed. Make final checks and corrections as required to all phases at the completion of the entire project.

1.24 FINAL ADJUSTMENT

.1 Allow for a final adjustment, as directed by the Departmental Representative. Revise the reports accordingly.

1.25 POST- OCCUPANCY TAB

.1 Participate in systems check during Warranty Period – Visit approximately 6 months after acceptance.

.2 During visits, be prepared to:

.1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, noise levels, in occupied zone as directed by Departmental Representative once building as occupied.

Part 2 Products

.1 Not used.

Part 3 Execution

.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- .1 ANSI/ASHRAE/IESNA 90.1-13, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society for Testing and Materials International, (ASTM)

- .1 ASTM B209M-10, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
- .2 ASTM C411-11, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .3 ASTM C449/C449M-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .4 ASTM C553-13, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .5 ASTM C612-00, Specification for Mineral Fiber Block and Board Thermal Insulation.
- .6 ASTM C795-08(2013), Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
- .7 ASTM C921-02, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.3 Canadian General Standards Board (CGSB)

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

.4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.

.5 Underwriters Laboratories of Canada (ULC)

- .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
- .2 CAN/ULC-S701-11, Thermal Insulation Polystyrene, Boards and Pipe Covering.

.6 South Coast Air Quality Management District (SCAQMD), California State

- .1 SCAQMD Rule 1113 - Architectural Coatings, - rules in effect January 1, 2004.
- .2 SCAQMD Rule 1168, Adhesive and Sealant Applications, January 2005 – rules in affect July 1, 2005.

1.2 DEFINITIONS

.1 For purposes of this section:

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

.2 "EXPOSED" - will mean "not concealed" as defined herein.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork.

.2 CRF: Code Rectangular Finish.

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

.2 Packaging Waste Management: in accordance with Section 01 74 11 - Cleaning.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Provide and apply insulation in accordance with TIAC National Insulation Standards Specification 1502, Commercial Duct and Plenum, and as herein specified.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with referenced standard.

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

.4 Type D-1: Rigid mineral fibre board with FSK reinforced foil and paper jacket.

.1 Mineral fibre: to ASTM C612.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum “k” factor: 0.0337 W/m°C.

.4 Density: 48 kg/m^3.

.5 Type D-2: Mineral fibre blanket with FSK reinforced foil and paper jacket.

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: 0.0337 W/m°C.

.4 Density: 16 kg/m^3.

2.3 JACKETS

.1 Canvas:

.1 220 gm/m^2 fire resistant cotton, plain weave, to ASTM C921 and ULC listed.

.2 Lagging adhesive: inorganic, water-based fire-resistive lagging adhesive and coating, ULC listed, Maximum VOC Content: 70 g/L (less water).

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

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

.1 Maximum VOC limit 70 g/L to SCAQMD Rule 1168.

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation, Maximum VOC Content: 150 g/L to SCAQMD Rule 1113.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

.4 Contact adhesive: quick-setting

.1 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.

.5 Canvas adhesive: washable.

.1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.

.6 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.

.7 Tie wire: 1.5 mm stainless steel.

.8 Banding: 19 mm wide, 0.5 mm thick stainless steel.

.9 Fasteners: 14 gauge diameter pins with 30mm diameter or 927 mm^2 square clips, pin length to suit thickness of insulation.

.10 Fire-rated insulating blanket: as required by manufacturer to maintain listing.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

.1 Pressure testing of ductwork systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer's instructions and as indicated.

.3 Use two layers with staggered joints when required nominal thickness exceeds 50mm. Where multiple layers are required, layer nearest duct need not require jacket.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports to be outside vapour retarder jacket.

.2 Seal all penetrations and joints with tape or vapour retarder adhesive.

.5 Supports, hangers in accordance with 'Hangers and Supports for HVAC Piping and Equipment'.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: At 300 mm on centre in horizontal and vertical directions, minimum two rows each side.

.7 Where ducts are internally insulated, thickness of internal lining may be deducted from external insulation.

.8 Type D-2 insulation may be substituted for Type D-1 insulation on rectangular ductwork if the ductwork has no dimension greater than 500mm.

.9 Round ducts greater than 600mm diameter requiring insulation, apply Type D-1 rigid board scored to accommodate curvature of duct.

3.3 JACKETS

.1 Applied to insulation where located as follows:

.1 Indoor, concealed:

.1 No additional finish required.

.2 Indoor, exposed:

.1 Rectangular: To TIAC Code CRF/2: Apply continuous metal corner bead and apply vapour barrier tape. Cover with canvas with fabric adhesive, and apply one (1) coat of fabric coating.

.2 Round: To TIAC Code CRD/2: Cover with canvas with fabric adhesive, and apply one (1) coat of fabric coating.

3.4 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: Conform to following table:

Service	Type	Vapour Retarder	Thickness (mm)
Return or exhaust air ducts (except as noted otherwise)	None	N/A	n/a
Exhaust or outside air duct between penetration of building envelope and damper, and 1800mm inside building from warm side of damper or to fan	D-1 (rectangular), D-2 (round)	Yes	50

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible 2005.

1.2 SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:

.1 Flexible connections.

.2 Duct access doors.

.3 Instrument test ports.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

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

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturer's Field Reports: manufacturer's field reports specified.

.7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 33 00 – Submittal Proceedures.

Part 2 Products

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

.1 Frame: 75 mm wide aluminum sheet metal frame, 0.7 mm thick, with fabric clenched by means of double locked seams.

.2 Material:

.1 Indoor application: fire-resistant, self-extinguishing, neoprene-coated glass fabric, temperature rated at -40ºC to 90ºC, 0.63 mm thick, and density of 1.02 kg/m^2. Meets the flame-resistance requirements of CAN/ULC-109M.

2.3 INSTRUMENT TEST PORTS

.1 Aluminum to suit duct material.

.2 Heavy duty leak-proof screw cap.

.3 Inside diameter to allow insertion of pitot tubes and other testing instruments. Length to suit insulation thickness.

.4 Neoprene mounting gasket, flat or curved to suit duct profile.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:

.1 Inlets and outlets to supply air units and fans.

.2 Inlets and outlets of exhaust and return air fans.

.3 As indicated.

.2 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

.1 Ducting on sides of flexible connection to be in alignment.

.2 Ensure slack material in flexible connection.

.2 Instrument Test Ports:

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Locations:

.1 For traverse readings:

.1 Inlets and outlets of other fan systems.

.2 Main and sub-main ducts.

.3 And as indicated.

.2 For temperature readings:

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible 2005.

1.2 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 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 11 - Cleaning.

Part 2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

.1 Of same material as duct, but at least one sheet metal thickness heavier.

.2 Size and configuration to recommendations of SMACNA,

.3 Round: frame with stiffening beads, continuous shaft for blades over 200 mm diameter.

.4 Locking quadrant with shaft extension to accommodate insulation thickness.

.5 Inside square end bearing and outside spring-loaded round end bearing.

.6 Vibration-free operation.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

.7 Corrections and adjustments conducted by Engineer.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Air Conditioning and Mechanical Contractors (AMCA)

.1 AMCA Publication 99-10, Standards Handbook.

.2 AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.

.3 AMCA 301-06, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.4 AMCA Standard 260-7, Laboratory Methods of Testing Induced Flow Fans for Rating.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1 ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.2 ANSI/AMCA Standard 300-08, Reverberant Room Method for Sound Testing of Fans.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.

1.2 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

.2 Capacity: flow rate, static pressure, bhp, kW, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

.4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal.

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 Shop Drawings:

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

.3 Provide :

.1 Fan performance curves showing point of operation, BHP, kW and efficiency.

.2 Sound rating data at point of operation.

.4 Indicate:

.1 Motors, sheaves, bearings, shaft details.

.2 Minimum performance achievable with variable speed controllers as appropriate.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

.6 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 33 00 – Submittal Proceedures.

1.4 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 33 00 – Submittal Proceedures.

.1 Spare parts to include:

.1 Matched sets of belts.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 11 - Cleaning.

Part 2 Products

2.1 FANS GENERAL

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 For use with variable speed controllers.

.3 Sizes as indicated.

.2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment. Inlet and outlet dampers as indicated.

.3 Factory primed before assembly in colour standard to manufacturer.

.4 Scroll casing drains: as indicated.

.5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

.7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 IN-LINE CENTRIFUGAL AND MIXED FLOW FANS

.1 Casings: welded steel with welded motor support, hinged or bolted access plates, streamlined inlet cone and discharge bell sections.

.2 Fan wheels:

.1 Welded steel or aluminum construction, to match Acceptable Material scheduled.

.2 Maximum operating speed of centrifugal fans not more than 40 % of first critical speed.

.3 Air foil, forward curved or backward inclined blades, as indicated.

.3 Bearings: heavy duty, split pillow-block, flange mounted grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated L10 rating life of 100,000 hours. Extension tubes to outside of casing.

.4 Supports:

.1 Ceiling suspended units: support brackets welded to side of casing. Extend grease lubrication facilities to outside of casing.

.5 Belt drive:

.1 Adjustable V-belt drive. Provide internal belt fairing, external belt guards and adjustable motor mounts.

.6 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 FAN INSTALLATION

.1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Provide sheaves and belts required for final air balance.

.3 Bearings and extension tubes to be easily accessible.

.4 Access doors and access panels to be easily accessible.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Air Movement & Control Association International Inc.

.1 AMCA Standard 500-L-12, Laboratory Methods of Testing Louvers for Rating.

.2 AMCA Standard 511-13, Certified Ratings Program for Air Control Devices.

.2 American Society for Testing and Materials (ASTM)

.1 ASTM E90-09, Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 HVAC Duct Construction Standards - Metal and Flexible 2005.

1.2 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 Schedule with the following data for each hood and louvre:

.1 Type and model number.

.2 Face area.

.3 Free area.

.4 Air flow rate and pressure drop.

.5 Mounting method and installation instructions.

.3 Finish colour sample.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Test Reports:

.1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 FIXED LOUVRES

.1 General Requirements:

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

.4 Frame, head, sill and jamb: one piece extruded aluminum, minimum 2 mm thick with approved caulking slot, integral to unit. Depth as indicated.

.5 Mullions: at 1500 mm maximum centres.

.6 Fastenings: stainless steel with nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.

.7 Birdscreen: 25 mm square mesh of 2.7 mm diameter aluminum wire on inside face of louvre in formed U-frame.

.8 Mounting method: to suit wall construction. Confirm with Departmental Representative.

.9 Finish: factory applied coating. Colour: selected by Departmental Representative.

.10 Performance ratings: licensed to bear the AMCA seal, tested and rated in accordance with AMCA Standards 500-L and 511.

.2 Features and performance: As scheduled.

Part 3 Execution

3.1 INSTALLATION

.1 In accordance with manufacturer's and SMACNA HVAC Duct Construction Standards recommendations.

.2 Confirm rough opening sizes and mounting methods with Departmental Representative prior to shop drawing submission.

.3 Install plumb and level.

.4 Anchor securely into opening with concealed fasteners.

.5 Pack gaps between frame and opening with insulation. Seal perimeter with caulking and backing rod to ensure weather tightness, sealant colour to be approved by Departmental Representative.

.1 Maximum VOC Content: 250 g/L (less water)

.6 Ensure birdscreens are in place.

3.2 MANUFACTURER'S INSTRUCTIONS

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE, Applications Handbook 2011, SI Edition.

.2 Canadian Standards Association (CSA International).

.1 C22.2 No.205-12, Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).

.1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

.4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.

.1 MD13800, Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.2 SYSTEM DESCRIPTION

.1 Controllers shall be Delta Controls type to be compatible with the existing building controls system. Any new controllers shall communicate with existing system.

.2 Installer of new controllers to be a licensed Delta Controls technician.

.3 Existing system graphics are to be updated to include new exhaust system and any changes to AHU-PHYTO.

.4 Provide sufficient controllers to meet intents and requirements of this section.

.5 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

.6 Controllers: stand-alone intelligent Control Units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device (HMI).

.7 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring (if remote units).

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA;

.2 0 - 10 V DC;

.3 100/1000 ohm RTD input;

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 – 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

.2 Switch up to 5 amps at 220 V AC using optional interface relay.

.8 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.

.9 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.

.3 Mounting details as approved by Departmental Representative for ceiling mounting.

.10 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.11 Provide surge and low voltage protection for interconnecting wiring connections.

1.3 SUBMITTALS

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

.1 Submit product data sheets for each product item proposed for this project.

.2 Submit BTL certificates for all BACnet controllers and routers.

.3 Submit wiring diagrams for each type of controller.

.4 Provide panel layout and drawings.

.5 Provide installation instructions for all products used in this project.

Part 2 Products

2.1 CONTROLLER SOFTWARE

.1 Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the HMI.

.2 System Security

.1 User access shall be secured using individual security passwords and user names.

.2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.

.3 User Log On/Log Off attempts shall be recorded.

.3 Scheduling. Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:

.1 Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop and optimal start. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each member.

.2 Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

.4 Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions.

.5 Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.

.6 Sequencing. Provide application software to properly sequence the start and stop of chillers, boilers, and pumps to minimize energy usage in the facility.

.7 PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and PID gains shall be user-selectable.

.8 Anti-Short Cycling. All binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

.9 On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and setpoint. The algorithm shall be direct-acting or reverse-acting, and incorporate an adjustable differential.

.10 Run-time Totalization. Provide software to totalize run-times for all binary input objects. A high run-time alarm shall be assigned, if required, by the operator.

Part 3 Execution

3.1 GENERAL

.1 Provide all components necessary to update the existing systems.

.2 Provide all design required to install systems as specified.

3.2 LOCATION

.1 Location of Controllers to be approved by Departmental Representative.

3.3 INSTALLATION

.1 Install Controllers in secure locking enclosures as indicated or as directed by Departmental Representative.

.2 All controls shall be fed from uninterrupted power supply from the central UPS system. Provide necessary power from local 120 V branch circuit panel fed from central UPS for equipment.

3.4 PROGRAMMING

.1 Provide all programming necessary to meet the specified functions.

.2 Program in a manner that is logical and easy to follow. Insert commentary when necessary to provide clarity to the sequences.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI).

.1 ANSI C12.7, Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM B148, Standard Specification for Aluminum-Bronze Sand Castings.

.3 National Electrical Manufacturer's Association (NEMA).

.1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Air Movement and Control Association, Inc. (AMCA).

.1 AMCA Standard 500-D, Laboratory Method of Testing Dampers For Rating.

.5 Canadian Standards Association (CSA International).

.1 CSA-C22.1, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.2 SUBMITTALS

.1 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in water-resistant, shockproof, vibration-proof, heat resistant assembly.

.3 Operating conditions: 0 to 32 degrees C with 10 to 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.

.8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 ELECTROMECHANICAL RELAYS

.1 Requirements:

.1 Double voltage, DPDT, plug-in type with termination base.
.2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
.3 Contacts: rated at 5 amps at 120 V AC.
.4 Relay to have visual status indication

2.3 SOLID STATE RELAYS

.1 General:

.1 Relays to be socket or rail mounted.
.2 Relays to have LED Indicator
.3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
.4 Operating temperature range to be -20 degrees C to 70 degrees C.
.5 Relays to be CSA Certified.
.6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
.7 Operational frequency range, 45 to 65 HZ.

.2 Input:

.1 Control voltage, 3 to 32 VDC.
.2 Drop out voltage, 1.2 VDC.
.3 Maximum input current to match AO (Analog Output) board.

.3 Output.

.1 AC or DC Output Model to suit application.

2.4 CURRENT TRANSDUCERS

.1 Requirements:

.2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA DC.
.2 0-1 volt DC.
.3 0-10 volts DC.
.4 0-20 volts DC.

.3 Frequency insensitive from 10 - 80 hz.

.4 Accuracy to 0.5% full scale.

.5 Zero and span adjustments. Field adjustable range to suit motor applications.

.6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.5 CURRENT SENSING RELAYS

.1 Requirements:

.1 Suitable to detect belt loss or motor failure.
.2 Trip point adjustment, output status LED.
.3 Split core for easy mounting.
.4 Induced sensor power.
.5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.
.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
.7 Adjustable latch level.

2.6 POWER SUPPLIES AND LINE FILTERING

.1 Control transformers shall be UL Listed. Furnish Class 2 current-limiting type, or furnish over-current protection in both primary and secondary circuits as per CEC requirements. Limit connected loads to 80% of rated capacity.

.2 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

.1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.
.2 Line voltage units shall be UL Recognized and CSA Approved.

.3 Power line filtering.

.1 Provide transient voltage and surge suppression for all controllers either internally or as an external component. Surge protection shall have the following at a minimum:

.1 Dielectric strength of 1,000 volts minimum

.2 Response time of 10 nanoseconds or less

.3 Transverse mode noise attenuation of 65 dB or greater

.4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.7 WIRING

.1 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.

.2 Wiring must be continuous without joints.

.3 Sizes:

.1 Field wiring to digital device: #18AWG.

.2 Analog input and output: shielded #18 minimum solid copper.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

.5 Fire stopping: provide space for fire stopping in accordance with base building standards. Maintain fire rating integrity of fire separations for all penetrations through Phytotron walls.

.6 Electrical:

.1 Complete installation in accordance with Section 26 05 00 - Common Work Results – Electrical.

.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.3 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

.4 Install communication wiring in conduit.

.1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Maximum conduit fill not to exceed 40%.

.4 Design drawings do not show conduit layout.

.5 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

3.2 IDENTIFICATION

.1 Identify field devices in accordance with base building standards.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 The following sequences shall be controlled through the ECMS, unless otherwise approved by the Departmental Representative.

.2 Provide all points required to execute the sequences specified, operate the equipment safely, for protection and alarms when failures occur, indicate system performance, assist in problem diagnosis, and for good energy management.

.3 Provide alarms with logic, auto adjustment, automatic seasonal override and time delays required to eliminate false alarms.

.4 PID control shall be available for all control loops, and implemented where appropriate, unless it can be demonstrated that PI control will provide stable and satisfactory control for the specific application.

.5 All control loop design, scheduling and sequencing shall be reviewed and approved by Departmental Representative prior to implementation.

1.2 REFERENCES

.1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.

.1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.3 SYSTEM CONTROL SEQUENCES – GENERAL

.1 This section specifies general requirements that apply to all control system connected to the EMCS in the project.

.2 Present sequences of operation for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.

.3 The following sequences outline the system requirements. Also refer to mechanical equipment specifications and schedules.

.4 Provide all controls required for complete working systems including features specified. Include devices and points as required to allow sequence of operation to be achieved as specified, even if not explicitly included in points list.

.5 Ensure all controls are compatible, including those provided by others. Show the detailed interfaces on the control shop drawings (i.e. packaged equipment wiring diagrams).

.6 All setpoints shown are suggested initial values only, to be adjusted as required during commissioning.

.7 All setpoints shall be user-adjustable at the operator workstation. Restrict setpoint adjustment by user access level (lowest access level = no adjustment, highest access level = all setpoints can be adjusted). Confirm setpoint adjustment access level restrictions with Departmental Representative. Allow for 3 user access levels.

.8 Abbreviations:

AHU - air handler
AI - analog input
AO - analog output
MA - mixed air
OA - outside air
CSR* - current sensing relay
OAT - OA temperature
OWS - operator workstation (system terminal)
DI - digital input
RA - return air
DO - digital output
RF - return fan
EA - exhaust air
SA - supply air
ECMS - energy control and Management system
SF - supply fan
SP - static pressure
EF - exhaust fan
VFD - variable frequency drive
* Or CT (current transducer) as appropriate to application.

.9 All sequences shall provide for safe and effective start and stop routines, including:

.1 TD on fan shutdown with electric heating coils

.2 ramp starts

.3 dampers on exhaust fans and 100% OA air handling units 100% open before fan start

.4 interlocks with TD as appropriate to suit transient conditions.

.10 Provide airflow proving switches on air handling systems to enable normal control sequences.

.11 Monitor all motor driven equipment for status using current sensing relays, unless proof of actual operating status is available by other means (e.g. output from VFD).

.12 Design all systems required to activate on fire alarm for fail safe operation, such that loss of signal from the fire alarm interconnection shall initiate sequence.

.13 Accuracy to be ±0.5°C for all temperature controls. Control space temperature ±1°C, and space humidity ±5% RH, unless otherwise specified.

.14 Temperature reset sequences shall be designed such that they are stable and minimize overshoot and hunting. Loops shall be self-tuning and provide the operator with the ability to fine tune their operation.

.15 Sequences shall utilize common outside air sensor and common outside air humidity sensor as required to achieve control functions, unless otherwise specified.

.16 Monitor position of shut-off/isolation dampers using end switch independent of the actuator and report to the ECMS.

.17 Monitor building electrical power status via physical connection to the main emergency power transfer switch. EMCS shall positively identify if building is on normal power or emergency power and initiate sequences accordingly.

.18 Where analog points are specified, control valves shall be true modulating control. Floating point control is not acceptable unless specifically indicated.

1.4 ECMS SOFTWARE APPLICATION – GENERAL

.1 Implement following control strategies and techniques within ECMS software developed for all systems controlled by ECMS controllers, unless otherwise specified. Control setpoints shall be as described in individual system sequences of operation specified in this section. They shall be obtained and/or adjusted at the OWS.

.2 Minimum OA control (systems with OA flow measuring stations) – maintain minimum OA flow rate measured directly by airflow measuring station located in OA intake duct. If SA temperature falls more than 2ºC below setpoint, minimum OA shall be reduced to provide largest minimum OA possible while SA temperature setpoint is maintained. Initiate alarm at OWS.

.3 Supply air volume control (variable volume systems) – modulate SF speed to maintain SA duct static pressure setpoint, subject to duct high limit static pressure setpoint.

.4 Return/exhaust air volume control (variable volume systems) – modulate RF/EF speed to maintain RA/EA duct static pressure setpoint, subject to duct low limit duct static pressure setpoint.

.5 Building pressure relief dampers shall be controlled from space static pressure referenced to outdoors.

.6 Supply air temperature control – modulate, when applicable, OA and RA dampers, heating and cooling equipment in sequence to maintain SA temperature setpoint. SA temperature control shall interact with minimum OA control and system shall revert to minimum OA flow rate on signal from comparative enthalpy economizer changeover controls specified in individual sequences of operation in this section. SA temperature setpoint shall be automatically reset where noted in individual sequences of operation in this section.

.7 Ramp functions – apply where control loops are subject to rapid load changes (i.e. SF volume control on system start-up, OA damper control on system start-up, MA and discharge air temperature control when systems are manually switched to 100% OA mode of operation, etc.). Ramp functions shall be implemented to prevent system overshoot, cycling and nuisance tripping of low limit protection devices.

.8 Provide the ability to disable and/or limit the range of manual setpoint adjustment of zone temperature sensors. Confirm adjustment ranges with Departmental Representative and Departmental Representative during commissioning.

1.5 FAN SYSTEM CONTROLS – GENERAL

.1 Following control sequences shall apply to all supply fan systems whether specifically noted in sequence of operation or not.

.2 Provide interlocks to ensure system controls energize and associated RF and/or EFs run when SF runs.

.3 Provide interlocks to ensure auxiliary equipment such as humidifiers, humidifier valves, OA dampers, relief air dampers, etc., are shut off and/or closed when supply fan is off.

.4 Where steam, hot water or glycol heating coils are utilized, the MA temperature controller shall modulate media flow through coil when supply fan is off in order to prevent overheating/overcooling condition within system plenum and/or ductwork.

.5 Where hot water or glycol heating coils have coil circulating pumps and control valves associated with them, provide interlocks to ensure that circulating pump shall run automatically when OAT is below 12.8ºC.

.6 Provide all fan systems that introduce OA with low limit control in discharge air to shut down supply fan and alarm on the ECMS when discharge air temperature drops below 5ºC. Locate low limit in manner that shall protect heating and cooling coils, and not be subject to nuisance tripping. Low limit shall be manual reset.

.7 Where relief air dampers are not directly ducted to supply/return fans, provide modulating back-draft temperature controller to prevent back-draft condition from occurring.

.8 On systems with duct static pressure control of fan speed, static pressure sensor shall be located at the end of the longest duct run. Confirm with Departmental Representative prior to installation. Provide second independent static pressure sensor located in supply

fan discharge or exhaust/return fan inlet to function as high limit and override control of fan volume device to prevent over-pressurization of system.

.9 On 100% OA systems provide end switch on OA damper to ensure OA damper is fully open prior to starting fan. End switch shall be independent of damper actuator, and shall prove damper is open, not actuator stroke.

.10 On exhaust systems provide end switch on EA damper to ensure EA damper is fully open prior to starting fan. End switch shall be independent of damper actuator, and shall prove damper is open, not actuator stroke.

1.6 ALARMS

.1 Selectable as to local (at the problem), panel (at the control panel), remote (elsewhere on site), off site (contact monitored at off site location) or any combination of these. "Local" is required only when the equipment is remote from the panel, or specifically indicated.

.2 Capable of individually being disabled.

.3 Silence audible easily.

.4 Audible alarm of subsequent alarms.

.5 Annunciation where effective.

.6 Audible to be distinct from fire alarm and other alarms.

.7 All setpoints, whether user adjustable or determined by the EMCS, shall be alarmed using the following criteria:

.1 Analog inputs: Provide user-adjustable alarm limits above and below setpoint. Alarm when setpoint is out of range.

.2 Binary inputs: Provide alarming of all binary inputs when current state is opposite to desired state. Desired state for alarming shall be user selectable.

.3 Seasonal and scheduled states (i.e. different alarm setpoints for winter/summer modes, day/night, etc.).

.4 Complete with time delays or sliding scales where appropriate and as directed by Departmental Representative.

.8 Off-site alarm notification:

.1 Make provision for off-site notification via ECMS pager/cellular phone call-out system.

.2 Each alarm shall have a unique descriptor. Confirm descriptor format with Departmental Representative during commissioning.

.9 Non-critical alarms: similar to critical, but different visual signal without audible.

.10 Where control loops have reset schedules associated with them (i.e. HWS temperature reset based on OAT), high and low temperature alarm indication shall also be on sliding schedule. For example, if alarm limits are set at ±2ºC from setpoint, alarm will be

generated only if the sensed temperature is above or below present setpoint by 2ºC (i.e. if present setpoint is 85ºC then alarm limits are 83ºC and 87ºC). Indication available to operator shall include low end point of reset schedule, high end point of reset schedule, present setpoint, present high and low alarm limits, and sensed temperatures.

.11 Alarms shall be inhibited from reporting when the associated HVAC system is normally inactive (either seasonally, or on a time basis); e.g. supply air temperature outside normal limits when unit is shut down at night.

Part 2 Products

.1 Not Used.

Part 3 Sequences of Operation

3.1 GENERAL

.1 For additional information, refer to manufacturer's descriptions.

3.2 POWER FAILURE

.1 Provide safe automatic re-start following power failure and clearing of fire alarms, except where manual reset is requested by the Departmental Representative or safe re-start is not possible. Include a time delay to limit starts on multiple 'bumps' and to avoid simultaneous re-start with lights, etc. Provide details with shop drawing submission and review with Departmental Representative.

.2 Provide for positive identification of power status by connecting directly to contacts on an automatic transfer switch within the facility (refer to drawings in Division 26 for ATS location), or by other means as approved by the Departmental Representative.

3.3 PHYTOTRON AIR HANDLING SYSTEM (AH-PHYTO)

.1 Any items that represent a change from the original sequence are in ***Bold Red Italics***

.2 Equipment:

.1 Modular air handling unit complete with supply fan, pre-filters (summer/winter), final filters, glycol heating coil with pump, chilled water cooling coil, humidifier steam distribution grid, and OA isolation damper.

.2 Humidifier complete with packaged controller.

.3 Return fan complete with isolation, return and relief dampers.

.4 VFDs for supply fan.

.5 VFDs for return fan.

.6 Supply airflow measuring station.

.7 Return airflow measuring station.

.3 Points list:

.1 Analog inputs:

.1 Outdoor air temperature (common).
.2 Outdoor air relative humidity (common).
.3 Outdoor air CO_2 concentration (common).
.4 Return air temperature sensor.
.5 Return air humidity sensor.
.6 Supply air temperature (downstream of supply fan).
.7 Supply air relative humidity (downstream of supply fan).
.8 Return air CO_2 concentration.
.9 Pre-filter pressure drop (x2).
.10 Final filter pressure drop.
.11 Supply fan VFD speed.
.12 Exhaust fan VFD speed.
.13 Supply airflow measuring station.
.14 Return airflow measuring station.
.15 SA duct SP.
.16 General exhaust fan plenum SP.
.17 Space static pressure (measured in Phytotron)

.2 Analog outputs:

.1 HCV control.
.2 CCV control.
.3 Humidifier control (demand) signal.
.4 Supply fan VFD control signal.
.5 Return air damper.
.6 Relief air damper.
.7 Outside air damper.

.3 Binary inputs:

.1 Supply fan status.
.2 Exhaust fan status.
.3 Supply fan VFD trouble/fault.
.4 Exhaust fan VFD trouble/fault.
.5 Supply air temperature low limit switch.
.6 Humidifier fault.
.7 Phytron Operator ventilation override (push button).
.8 ***Growth chamber exhaust fan status.***

.4 Binary outputs:

.1 Supply fan VFD start/stop.
.2 Return fan VFD start/stop.

.3 Humidifier enable/disable.

.4 Control Loops:

.1 Time:

.1 Occupied Mode:

.1 AHU and RF run continuously.

.2 Unoccupied Mode:

.1 AHU and RF run continuously, at reduced airflow rates.

.2 Heating:

.1 Modulate HCV to maintain return air temperature at setpoint.

.3 Cooling:

.1 Modulate CCV to maintain return air temperature at setpoint.

.4 Damper Control:

.1 OA damper and relief dampers are closed and return air damper is open when system is off.

.2 OA damper is at minimum position unless there is a call for “free cooling”.

.3 Free cooling (economizer): Modulate open OA damper to maintain return air temperature at setpoint. Return air damper inversely tracks OA damper.

.4 Relief air damper: modulate relief air damper to maintain space pressure setpoint of -5 Pa (user adjustable).

.5 Humidification:

.1 Packaged humidifier controls modulate steam control valve in response to modulating signal from ECMS.

.2 Provide reset of humidification according to the following schedule:

Outside air temperature	Relative humidity setpoint
≤-20°C	25%
10°C	35%

.3 Limit supply air RH to 90% maximum. Refer to ‘Safeties’.

.6 Fans:

.1 Occupied:

.1 AHU and EF run continuously.

.2 Modulate supply fan VFD to maintain supply duct static pressure setpoint (constant volume system).

.3 Modulate return fan VFD to match return air volume to supply volume as measured by AFMS.

.2 Unoccupied:

.1 Not used.

.3 Monitor and display at OWS total OA flow rates, and RA CO_2 concentration.

.7 Operator Ventilation override:

.1 Local control panel in Phytotron gives operator ability to increase outside air flow rates to 100% for pesticide spraying operations.

.1 When switch in override position (100% OA), open outside air damper to 100% open, close return air damper and open relief air damper.

.2 When switch is returned to normal position (minimum OA), outside air damper returns to minimum position, return damper opens proportionally. Relief damper modulates to maintain space static pressure.

.3 ***Minimum unit relief/exhaust air and/or minimum outside air to be increased to be reduced by the amount of the new air to accommodate the new growth chamber exhaust fan system.***

.4 Provide advisory alarm to Building Operator at OWS when system is placed in override position. Repeat advisory after 12 hrs. Non-critical alarm if system is left in override for more than 24 hrs. Repeat alarm every 24hrs until system is returned to normal.

.8 Interlocks:

.1 AHU with RF:

.1 RF starts before both SFs.

.2 Controls with airflow.

.9 Safeties:

.1 Low SA temperature: Provide manual low limit switch set at 5°C.

.2 High SA RH: alarm and reduce RH setpoint until SA humidity drops below alarm threshold.

.3 High SA duct SP: alarm and reduce SF speed so that SA duct SP $\leq$ +500Pa.

.4 High RA SP: alarm and reduce RF speed so that RA duct SP $\leq$ -500Pa.

3.4 MISCELLAENOUS STAND-ALONE EXHAUST SYTEMS

.1 Equipment:

.1 Exhaust fan with motorized damper.

.2 Points:

.1 Binary output:

.1 Motorized damper open/closed.

.2 Fan start/stop.

.2 Binary input:

.1 Fan status (CSR).

.3 Growth Chamber Exhaust (Phytotron):

.1 Fan operates on time schedule (as set by operator).

.2 Alarm if fan status is opposite desired state.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This Section covers items common to Sections of Division 26. These sections supplement requirements of Division 01.

1.2 CODES AND STANDARDS

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

.2 While not identified and specified by number in these Divisions, comply with CSA Electrical Bulletins in force at time of tender submission. Comply with the requirements of all provincial and local laws, rules, ordinances and codes.

.3 Electrical installation shall be in accordance with current edition of the Canadian Electrical Code, Provincial and other codes, rules and regulations. It is not the intention of the drawings and specifications to reiterate the Code. It is expected that the Contractor will be responsible for access panels, ground fault receptacles, wire sizes and methods, conduit sizes, fire rating of cables, coordination of circuit protection components, fire alarm ancillary devices, exit and emergency lighting requirements, specialty ratings for cable for elevators etc. Notify the Departmental Representative of any detected code deficiencies prior to submission of tender. In the absence of such notifications, it will be assumed that the Contractor has accepted responsibility for a complete code-compliant installation, and no additional compensation will be provided for code-related items.

.4 Supply materials and labour required to meet requirements of codes, rules and regulations, whether or not such work is indicated on the drawings or in specifications.

.5 Where Divisions 26 specifies better quality of construction (or materials) than minimum code requirements, the more expensive of the two will be provided.

.6 Electrical installation shall be in accordance with the requirements of the Authority having Jurisdiction.

.7 Do underground systems in accordance with CSA C22.3 except where specified otherwise.

1.3 CARE, OPERATION AND START-UP

.1 Instruct Departmental Representative in the operation, care and maintenance of systems, system equipment and components. Arrange care and instructional sessions to be provided at a time convenient to the Departmental Representative.

.2 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that Departmental Representative are conversant with all aspects of its care and operation.

1.4 VOLTAGE RATINGS

.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. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.5 PERMITS, FEES AND INSPECTION

.1 Furnish Certificates of Acceptance from Authority having Jurisdiction upon completion of work to Departmental Representative. Include copies of certificate in maintenance manuals.

1.6 MATERIALS AND EQUIPMENT

.1 Electrical equipment shall be new and of the type and quality specified.

.2 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Authority having Jurisdiction.

.3 Provide labour, materials, transportation, equipment and facilities, etc. required for the complete electrical installation as indicated or can be reasonably implied from the drawings and specifications.

.4 Provide factory assembled control panels and component assemblies.

.5 Provide minimum 1500mm clearance and access/working space at all equipment access doors/panels, breakers, switches, transformers, controls, etc. that is rated 1200A or more or rated over 750V and minimum 1000mm clearance in all other areas.

.6 Equipment shall not be located near pipe shafts or fluid piping.

.7 Equipment, conduits and cables shall not restrict or interfere with necessary access space required to safely service mechanical equipment (ventilation fans, filters, etc.) which are existing and/or to be installed under this contract.

1.7 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.2 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 volts, related to control systems, are may be specified in Division 25.

.3 All electrical connections, terminations, power requirements related to electrical work shown on architectural or mechanical drawings are to be included by this Division.

1.8 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for incorporation into operation and maintenance manuals. Refer to Section 01 33 00 – Submittal Proceedures. Operation and maintenance manuals shall be submitted to Departmental Representative in time to be used in the commissioning of the project.

.2 Include detail of design elements, construction features, components function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation.

.3 Include technical data, product data; supplement by bulletins, component illustration, exploded views, technical description of items, and parts lists. Advertising or sales literature will not be accepted.

.4 Include wiring, schematic diagrams and performance curves.

.5 Maintenance manuals shall be submitted to Departmental Representative for review. Manuals that are incomplete shall be returned to Contractor for completion. Completed manuals must be submitted, to the satisfaction of the Departmental Representative before final payment may be considered to be due.

1.9 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

.1 Submit shop drawings, product data and samples for review by Departmental Representative. Refer to Section 01 33 00 – Submittal Procedures. Manufacture of equipment must not commence until shop drawings have been reviewed.

.2 Indicate detail construction, dimension, capacities, weights and electrical performance characteristics of equipment or material.

.3 Where applicable, include wiring, single line and schematic diagrams.

.4 Include wiring drawings or diagrams showing interconnection with work of other sections.

.5 Shop drawing submissions shall include a photocopy of all applicable specification sections showing a complete compliance/non-compliance listing.

.6 Each drawing submission to bare following signed stamp, and include name of project, equipment supplier and clause number equipment is specified under.

CONTRACTORS CERTIFICATION

This drawing has been reviewed by

(firm name)

All dimensions have been checked and found compatible with the contract drawings and all capacities, quantities, sizes and other data contained in the contract documents have been listed by the supplier on this drawing and have been checked by the undersigned and found correct.

Date

Per

.7 Clearly show division of responsibility. No item, equipment or description of work shall be indicated to be supplied or work to be done `By Others' or `By Purchaser'. Any item, equipment or description of work shown on shop drawings shall form part of the contract, unless specifically noted to the contrary.

.8 Provide field dimensions required by Contractor. In cases where fabrication is required prior to field dimensions being available, check all related drawings and obtain clarification from Departmental Representative if necessary.

.9 Division 26 shall check all shop drawings and make necessary changes, prior to submission to the Departmental Representative. They will be reviewed and, if re-submission is required, Division 26 shall ensure that the supplier's drawings have been changed to comply before returning them to the Departmental Representative for another review. If the drawings still do not comply, and require additional review by the Departmental Representative, the Departmental Representative shall be reimbursed by Division 26 for the time required for such additional reviews.

.10 Review of the shop drawings by the Departmental Representative shall not relieve the Contractor from responsibility for errors and omissions therein.

.11 Shop drawings reflecting additional design or change in design shall be reviewed by the Departmental Representative.

.12 Provide shop drawings for all electrical components, including but not limited to wiring devices, lamps, starters, luminaires, etc.

1.10 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Paint outdoor electrical equipment "equipment green" finish to EEMAC Y1-1-1955, unless otherwise noted.

.2 Paint indoor distribution enclosures light grey to EEMAC 2Y-1-1958.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.1 Maximum VOC Content for paint applied on site: 50g/L (less water) in accordance with Green Seal Environmental Standard GS-11, Paints and Coatings, First Edition, May 20, 1993.

.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.11 WIRING TERMINATIONS

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminium conductors.

1.12 MANUFACTURERS AND CSA LABELS

.1 Visible and legible, after equipment is installed.

1.13 LOAD BALANCE

.1 Measure phase current to panelboards with normal loads 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 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. Record hour and date on which each load was measured, including voltage at time of test.

1.14 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 steel pipe sized for free passage of conduit, and protruding 50 mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

1.15 CUTTING AND PATCHING

.1 Pay the costs of all cutting and patching required for the installation of electrical work. Refer to 01 73 00 - Execution.

.2 Cutting and patching required for the installation of electrical work shall be done by the particular trade whose work is involved.

.3 Obtain the approval of the Departmental Representative before arranging for any cutting. Patching shall restore the affected area to the original condition.

.4 Cutting or patching shall be carried out by the Contractor.

1.16 CONDUIT, SLEEVES AND HOLES

.1 Make necessary arrangement for cutting of chases, drilling of holes and other structural work required to install electrical conduits, cables, pull boxes and outlet boxes. In existing facilities - Do Not core without Departmental Representative permission or without x-ray or scanning of floors.

.2 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete to be sized for free passage of conduit.

.3 Flash and weatherproof any penetrations or holes through exterior walls and roof.

.4 Install cables, conduits, and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to a minimum.

.5 All sleeves and access conduits shall protrude through the floor 25mm above finished floor surface.

.6 Provide fire-stop all floor and wall penetrations.

1.17 PROTECTION

.1 Protect exposed live equipment during construction for personnel safety.

.2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage in English.

.3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.

1.18 RECORD DOCUMENTS

.1 The Contractor shall keep a set of white prints on the job site at all times on which he shall record all additions or deviations from the contract documents including all changes covered by addenda, change orders, field changes, job conditions, etc. A set of drawings shall be utilized for each system and the Contractor shall obtain prints as required. Drawings to include locations of all junction and pull boxes, routing of feeders and conduits, and changes to circuit numbers. Refer to Section 01 78 00 – Closeout Submittals.

.2 All principle below grade or inaccessible conduits, systems, etc. shall be dimensioned at each change in direction. All conduit routes not shown by the Departmental Representative on original drawing shall be shown including circuit wiring, junction boxes, zoned conduit runs, etc.

.3 The Contractor to provide one set of clean marked-up drawings for approval and a final set with changes as may be requested by the Departmental Representative.

.4 If corrections are required after the second Departmental Representative review, due to missing information, the Contractor shall be responsible for the Departmental Representative time to indicate the required corrective measures and all courier and printing costs.

1.19 EQUIVALENT MATERIALS AND EQUIPMENT

.1 Bidder shall submit a tender based on the specified materials and equipment only.

.2 Bidders may submit a tender based on equivalent material and equipment, only if such items have been approved as equal by the Departmental Representative.

.3 Request for equal submissions shall include a photocopy of all applicable specification sections showing a complete compliance/non-compliance listing in the left hand margin. Every clause of the applicable specification section must be individually marked indicating details of how compliance is met or, how the non-compliance items should be considered equal.

.4 Submittal list will be returned by facsimile machine, where number is shown, or may be picked up at the Departmental Representative office when directed by the Departmental Representative. Where submissions are not returned by the Departmental Representative before tender or forty (40) working hours before close of tender, they are considered not approved.

.5 The approval of equivalent products will be granted on the basis of general design only. Such approvals will not relieve the Contractor from providing all necessary components and functions required in the specifications or on the drawings.

.6 Clearly show division of responsibility. No item, equipment or description of work shall be indicated to be supplied or work to be done `By Others' or `By Purchaser'. Any item, equipment or description of work shown on shop drawings shall form part of the contract, unless specifically noted to the contrary.

1.20 CO-ORDINATION WITH OTHER TRADES

.1 Refer to mechanical design drawings and specification for electrical work in connection with other divisions. The most stringent or restrictive requirement of specifications or drawings from any Division shall apply and be included in the tender price. This will be applicable even after the work was installed with the lesser requirement. Provide all required work to the full satisfaction of the Departmental Representative.

.2 Coordinate electrical work with Contractor to avoid conflict with pipes, air ducts and other equipment. Provide additional supports, wiring, etc. to all relocated equipment as required where relocation is necessary to avoid interferences.

1.21 EXAMINATION OF SITE

.1 Prior to submitting a tender, examine site and local conditions, which may affect work. Claims for extra payment resulting from conditions, which may have been foreseen during examination of the site, will not be recognized.

.2 Ensure that all equipment designated as “existing to remain” or “existing to be relocated” is suitable for its intended re-use, including panelboards and circuits. Report any discrepancies to the Departmental Representative before tender close.

1.22 PROCEDURE SCHEDULE

.1 All electrical work to be coordinated with Departmental Representative and Contractor involved. Manner and areas of work shall be pre-arranged prior to proceeding.

.2 Procedure schedule will be prepared by the Contractor in conjunction with the Departmental Representative to ensure continuity of work can be maintained with minimal interruption to occupant routine within the existing facilities. Contractor to coordinate his/her proposed schedule with the Departmental Representative in a manner satisfactory to all involved.

1.23 WORKMANSHIP

.1 Install equipment, conduits and cables in a workmanlike manner to present a neat appearance to the satisfaction of the Departmental Representative. Install conduit and cable runs parallel and perpendicular to building lines, in chases, behind furring or above ceilings, where such concealment is possible. In areas where systems are to be exposed, install neatly and group in a tidy appearance.

.2 Install equipment and apparatus requiring maintenance, adjustment or eventual replacement, with adequate clearance and accessibility for same.

.3 Include in the work all requirements shown on the shop drawings or installation instructions.

.4 Replace work unsatisfactory to the Departmental Representative without extra cost.

1.24 CLEANUP

.1 The Contractor shall at all times during construction, keep the site free of all debris, boxes, packing, etc.

.2 At the completion of the work, the electrical installation shall be left in a clean, finished condition to the satisfaction of the Departmental Representative.

1.25 DELIVERY, STORAGE AND HANDLING

.1 Deliver all materials to the site in an orderly fashion.

.2 Store all materials in a clean and dry place, secure from vandalism or theft. All materials to be left in shipping containers until required for use.

.3 Provide additional protection such as tarps, padding, wood skids, etc., where such is required to ensure protection of equipment and as directed by the Departmental Representative.

1.26 GUARANTEE/WARRANTY

.1 Satisfactory operation of all work and equipment installed under this contract shall be guaranteed for a period of one (1) year from the date of final acceptance of this work except where otherwise noted.

.2 All unsatisfactory work and any equipment that does not perform satisfactorily within the guarantee period shall immediately be repaired or replaced at no cost. The warranty on any replacement equipment or components shall be one year from the date of their installation.

.3 Any equipment that has been placed in use for any reason prior to the beginning of the guarantee period, such as for heating during construction, shall be cleaned and provided with whatever maintenance and repair is required so that its condition is equal to that of new equipment, or it shall be replaced, at no cost.

.4 Equipment that fails as a result of its use prior to the beginning of its one-year guarantee period shall be repaired or replaced at no cost, even after the normal one-year guarantee period has expired.

.5 All details of warranty repairs shall be documented in letters to the Departmental Representative.

.6 No certificate given, payment made, or the use of the equipment shall be construed as acceptance of defective work or of improper materials.

.7 This guarantee shall not act as a waiver for products that are warranted by the manufacturer for longer than one year.

1.27 DEFINITIONS

.1 The following are definitions of terms and expressions used in the Specification:

.1 **Departmental Representative** means the contractual entity.

.2 **Authority having Jurisdiction** means agent of any authority having jurisdiction over construction standards associated with any part of the electrical work on site.

.3 **Electrical Code** means Canadian Electrical Code or Local Code in force at Project location.

.4 **Indicated** means as shown on contract drawings or noted in contract documents.

.5 **Type Tested** means that each piece of equipment produced by manufacturer is not fully tested. An original piece with similar arrangement has been fully tested and results of that test are available.

.6 **Provide** means to supply, install and leave in working order all materials and necessary wiring, supports, access panels, etc., as necessary for equipment indicated.

Part 2 Products

.1 Not used.

Part 3 Execution

.1 Not used.

END OF SECTION

Part 1 General

1.1 COORDINATION

.1 Where existing services or systems, such as electrical power, telephone system, data systems, equipment alarm system, sump pumps, etc. are required to be disrupted and/or shut-down, coordinate the shut-downs with the Departmental Representative and carry out the work at a time and in a manner acceptable to them. Carefully schedule all disruptions and/or shutdowns and ensure the duration of same is kept to the absolute minimum. Refer to Section 01 14 00 – Work Restrictions.

.2 Should any temporary connections be required to maintain services or systems during work in the existing building, supply and install all necessary material and equipment and provide all labour at no extra cost. Should any existing equipment or system be damaged, make full repairs without extra cost, and to the satisfaction of the Departmental Representative.

.3 Comply with instructions regarding working hours necessary to maintain the building in operation.

.4 No drilling in concrete floors shall take place unless the floor has been scanned (or x-rayed) to confirm exactly what is in the floor. The Contractor to notify the Departmental Representative before drilling. The Contractor assumes complete responsibility for any and all damages or work stoppages occurring from unforeseen problems.

1.2 REMEDIAL WORK

.1 Ensure that any coring of holes through decks or floor slabs, will not penetrate existing conduits, cables or mechanical equipment in walls, ceilings or floor slabs. The Contractor, at his cost, is responsible to take all actions required and as may be deemed necessary by the Departmental Representative to correct any damage. No coring shall be undertaken unless permission is given by the Departmental Representative.

Part 2 Products

2.1 MATERIALS

.1 Provide all materials required for the complete interface and reconnection installation as herein described and as indicated on the drawings.

.2 Add modules, switches, etc., in existing control panels, as required, to extend existing systems to the new or renovated areas only. Confirm existing on site.

.3 It is the intent of these specifications to <u>not</u> re-use any existing wiring.

Part 3 Execution

3.1 INSTALLATION

.1 Install boxes, conduit and wiring through existing areas as required for the new installation.

.2 Patch and repair walls and ceilings in existing building that have been damaged or cut open due to the new electrical installation. Refer to Section 01 73 00 – Execution.

.3 Where new cables or conduits have been installed through existing fire rated walls, seal opening around cables and conduit to maintain fire rating.

.4 Test and confirm all existing grounding systems are effective and in good condition. Include work and materials required to change wiring and make good existing.

.5 Confirm the exact position and mounting height of each outlet prior to commencement of work. Special efforts are required to coordinate outlets, conduit routes, etc. with architectural, mechanical and other related work.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.2 No. 65 Wire Connectors.

.2 CSA C22.2 No. 18 Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.3 CSA C22.2 No. 0.3 Test Methods for Electrical Wires and Cables.

.4 CSA C22.2 No. 131 Type Teck 90 Cable.

Part 2 Products

2.1 WIRE CONNECTORS

.1 Copper long barrel compression connectors sized for conductors. Use two-hole long barrel compression connectors for feeder conductors.

.2 Solderless, self-insulated connectors for hand twist wire joints for lighting, small power, and associated control devices, with nylon insulator. Solderless, self-insulated connectors for hand twist wire joints for solid to stranded connections (e.g. heater thermostats), nylon insulator.

.3 Terminate conductors #8 AWG and larger with Color-Keyed compression connectors or on lugs provided with equipment. Use cable preparation compound for copper colloidal surface treatment that protects, lubricates and enhances conductivity between all electrical connections for protection against corrosion.

2.2 CABLE CONNECTORS

.1 Provide rain-tight connector fittings, complete with O-rings, for use on surface mounted weatherproof or sprinkler-proof enclosures. Side entrances to enclosures are preferred however when top entries are necessary rain-tight connectors must be used for all panels, contactors, motor control centres, etc.

2.3 RAIN-TITE COUPLINGS

.1 Rain-tight couplings shall be used for surface mounted conduits exposed to moisture or sprinkler heads.

Part 3 Execution

3.1 CABLE INSTALLATION

.1 Install cables for feeders or branch circuits in raceways, cable trays, wireways or trenches.

.2 Support on channels where cables are grouped and not run in tray.

.3 Run cables parallel to the lines of the building.

.4 Bends to be concentric.

.5 Seal cables which penetrate air barrier and vapour boxes to barrier and boxes.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA C22.2 No. 0.3 Test Methods for Electrical Wires and cables.

.2 CAN/CSA-C22.2 No. 131.

1.2 FIRE RATING

.1 Fire ratings shown are minimum required. Provide cable of fire rating as required by Authority having Jurisdiction.

.2 Fire rate entire cable support system. This shall include but not be limited to cable racks, support rods, anchors, etc.

Part 2 Products

2.1 CABLE IDENTIFICATION

.1 Cables to be identified with wire markers.

.2 Machine printed self laminating label type.

.3 Thermal transfer type with printable area and translucent vinyl film.

2.2 BUILDING WIRES

.1 Conductors in conduit:

- .1 Type: RW90, RWU90
- .2 Conductors for panel and branch circuits:
  - .1 Solid copper #10 AWG and smaller
  - .2 Stranded copper #8 AWG and larger.
  - .3 Sized as required (minimum #12 AWG).
- .3 Insulation:
  - .1 Cross link polyethylene (XLPE), 90°C.
- .4 Configuration:
  - .1 Single conductor.
- .5 Voltage Rating: 600V.
- .6 Certification:
  - .1 CSA C22.22 No. 38.

2.3 MINERAL-INSULATED CABLES

.1 Conductors: solid bare soft-annealed copper, size as indicated.

.2 Insulation: compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.

.3 Outer covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 degrees C.

.4 Overall jacket: none.

.5 Two hour fire rating.

.6 Connectors: watertight, field installed approved for MI cable.

.7 Termination kits: field installed approved for MI cable

2.4 ARMOURED CABLE

.1 Type: AC90 (BX).

.2 Conductors:
- .1 Solid copper #10 AWG and smaller.
- .2 Stranded copper #8 AWG and larger.
- .3 Sized as required (minimum #12 AWG).

.3 Insulation:
- .1 Cross link polyethylene (XLPE), 90°C.

.4 Configuration:
- .1 Multi-conductor, as required, complete with a separate bare CU ground wire.

.5 Voltage Rating: 600V.

.6 Armour: Bare inter-locked aluminum.

.7 Certification:
- .1 CSA C22.22 No. 51.

2.5 ARMOURED CABLE (TECK)

.1 Type: TECK 90

.2 Conductors for panel and branch circuits:
- .1 Solid copper #10 AWG and smaller.
- .2 Stranded copper #8 AWG and larger.
- .3 Sized as required (minimum #12 AWG).

.3 Insulation:
.1 Cross link polyethylene (XLPE), 90°C.

.4 Configuration:
.1 Single or multi-conductor, as required.

.5 Colour Code:
.1 Black, red, blue and white in 4/C cable. Cables of more than 4/C to be number coded.

.6 Voltage Rating: 600V.

.7 Inner Jacket:
.1 Black polyvinyl chloride (PVC).
.2 Low flame spread (LFS).
.3 Low gas emission (LGE).

.8 Armour:
.1 Inter-locked aluminum.

.9 Outer Jacket:
.1 Black polyvinyl chloride (PVC), -40°C.
.2 Low flame spread (LFS).
.3 Low gas emission (LGE).

.10 Fire Rating: FT4, AG14.

.11 Certification:
.1 CSA C22.22 No. 131.

2.6 VARIABLE FREQUENCY DRIVE CABLE:

.1 Cable:
.1 Variable frequency drive cable to CAN/CSA C22.2 No. 131.

.2 Conductors:
.1 Copper power and ground.

.3 Ground conductors:
.1 Three bare ground conductors spaced evenly around circumference of cable (sectored ground).

.4 Insulation:
.1 Cross linked polyethylene, 1000V.

.5 Armour:
.1 Continuous aluminum sheath formed into corrugates seamless heath.

.6 Outer jacket:
.1 PVC, UV resistant.

.7 Fire rating: FT4, HL and AG14.

.8 Connectors:
.1 As for RA90.

2.7 ELECTRONIC CABLES

.1 Conductors:
.1 #18 AWG - STC solid copper.

.2 Insulation:
.1 Polyvinyl chloride (PVC).

.3 Configuration:
.1 Twisted pairs (number as required).

.4 Shielding:
.1 Copper braid.

.5 Voltage Rating: 300V.

.6 Certification:
.1 CSA.

2.8 FIRE ALARM CABLES

.1 Conductor:
.1 Solid copper minimum #18 AWG.
.2 Minimum #12 AWG for signaling circuits, in accordance with installation instructions.

.2 Insulation:
.1 105°C. (221°F) flame retardant PVC.

.3 Configuration:
.1 Multi-conductor (minimum 4 conductors per cable).

.4 Voltage Rating: 300V.

.5 Conductor Identification:
.1 Colour coded.

.6 Shielding:
.1 Aluminum mylar foil.

.7 Outer Jacket:
.1 105°C. (221°F) red PVC jacket.

.8 Certification:
.1 CSA Class #5851-01 File #LR41741.
.2 UL subject 1424 File #E-83163.

2.9 LOW VOLTAGE CONTROL CABLES

.1 Type: LVT.

.2 Conductors:
.1 Solid copper #18 AWG.

.3 Insulation:
.1 Thermoplastic, colour coded.

.4 Configuration:
.1 Single, two conductors – parallel.
.2 Three or more conductors – twisted.

.5 Voltage Rating: 30V.

.6 Outer Jacket:
.1 Thermoplastic.

.7 Certification:
.1 CSA C22.22 No. 35.

2.10 INSTRUMENTATION CABLES

.1 Type: Instrumentation cable.

.2 Conductors:
.1 7-wire, concentric lay, Class B tinned copper, #18 or #14 AWG as required.

.3 Voltage Rating: 300V or 600V as required.

.4 Insulation:
.1 Fire retardant - cross link polyethylene (XLPE), 90ºC.

.5 Configuration:
.1 Single or multi pairs or triads, as required.

.6 Shielding:
- .1 Aluminum/mylar shield with drain wire for each pair triad.
- .2 Overall aluminum/mylar shield with drain wire.

.7 Drain Wires:
- .1 7-wire, concentric lay, Class B tinned copper.
- .2 Individual shields to be one size smaller than conductor size.
- .3 Overall shields to be the same as conductor size.

.8 Colour Codes:
- .1 300V Pairs:
  - .1 black, white and number code.
- .2 300V Triads:
  - .1 black, white and number code.
- .3 600V Pairs:
  - .1 black, red and number code.
- .4 600V Triads:
  - .1 black, red, yellow and number code.

.9 Armour:
- .1 Inter-locked aluminum.

.10 Outer Jacket:
- .1 Grey polyvinyl chloride (PVC).
- .2 Low flame spread (LFS).
- .3 Low gas emission (LGE).

.11 Fire Rating: FT4.

.12 Certification:
- .1 CSA C21.1 or latest revision.
- .2 CSA C22.2 No. 174 or latest revision.

2.11 CONNECTORS

.1 Pressure type connectors, fixture type splicing connectors, cable clamps and lugs, as required.

.2 Refer to Section 26 05 21 Wire and Box Connectors and 26 05 22 Connectors and Terminations.

Part 3 Execution

3.1 CABLE INSTALLATION & WORKMANSHIP

.1 Install cables for feeders or branch circuits in raceways, cable trays, wireways or trenches as required.

.2 Prevent over-heating by induction in accordance with rule 12-3022(7) and 4-010 and Appendix B Canadian Electric Code, Part 1 where single conductor cables connect to boxes and cabinets.

.3 Install sleeves where cables pass through poured concrete or masonry.

.4 Provide mechanical protection for cables where cables are turned up above the floor through sleeves or slots. Provide channels, angle sills or rigid conduit sleeves which protrude at least 150 mm above the finished floor.

.5 Where cables are grouped and not run in tray, support on channels.

.6 Run cables parallel to the lines of the building.

.7 Bends to be concentric.

.8 Seal cables which penetrate air barrier and vapour boxes to barrier and boxes.

.9 Perform tests in accordance with Canadian Electrical Code requirements.

3.2 PHASE BALANCING

.1 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting for optimum balancing.

.2 Record all changes on “as-built” drawings.

3.3 MINIMUM CABLE SIZE

.1 Minimum wire size to be #12 gauge throughout except where indicated otherwise.

.2 Be responsible for providing the minimum wire size to meet the code where the wire size shown on the drawing is inadequate to serve the load.

.3 Minimum size of panelboard and motor feeders is to be in accordance with CEC.

3.4 VOLTAGE DROP

.1 Size wiring for branch circuits to achieve a maximum 3% voltage drop.

.2 Base on distance from overcurrent device to furthest wiring device/load.

.3 Provide cable size for entire length of circuit.

.4 Submit voltage drop calculations when requested.

3.5 NEUTRAL CONDUCTORS

.1 Reduced neutrals not permitted.

.2 Provide separate neutrals for all dimmers, laser printers or as otherwise indicated.

3.6 GROUND CONDUCTORS

.1 Provide a green insulated ground conductor equal in size to current carrying conductors within all raceways.

3.7 FIRE SEPARATIONS

.1 Submit drawings showing proposed method of sealing fire separations.

3.8 INSTALLATION OF BUILDING WIRES

.1 Install wiring in conduit system in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Ensure conduits are dry and free of debris before pulling cables.

.3 Provide colour coding and identification as per this Section.

.4 Wires in outlet, junction and switch boxes, not having a connection within the box shall not be spliced, but shall continue unbroken through the box.

3.9 INSTALLATION OF MINERAL-INSULATED CABLES

.1 Install cable exposed, securely supported by hangers.

.2 Support 2 hour fire rated cables at 1 m intervals.

.3 Make cable terminations by using factory-made kits.

.4 Cable terminations: use thermoplastic sleeving over bare conductors.

.5 Do not splice cables unless indicated.

3.10 INSTALLATION OF ARMOURED CABLES (BX)

.1 Group cables wherever possible.

.2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors.

.3 Type AC90 armoured cable (Bx) with screw type connectors shall be used for connections from conduit systems to luminaires in accessible ceilings only.

.4 Type Bx cable shall not be used for any other application.

.5 Maximum length of AC90 armoured cable for connections to luminaires mounted in stud partitions shall be 1.5 metres. Cable drops for luminaires in accessible ceilings shall be of sufficient length to allow the luminaire to be relocated to any location within a 3m radius.

.6 Cable shall be clamped before entering the lighting fixture and shall be clipped before entering the conduit system junction box.

3.11 INSTALLATION OF ARMOURED CABLES (TECK)

.1 Group cables wherever possible on channels, spaced one (1) cable diameter apart.

.2 Do not splice cables.

.3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors. Terminate cables using non-magnetic connectors. Cable armour shall be grounded via an aluminum plate at the supply end and isolated via an insulating plate at the load end of the cable.

.4 Cable bending radius shall be at least twelve (12) times the overall cable diameter and bend shall not damage or distort the outer sheath.

.5 Do not install PVC jacketed cables in circulating air plenums.

3.12 INSTALLATION OF VARIABLE FREQUENCY DRIVE CABLE

.1 Install variable frequency drive cable from VFD to associated motor.

.2 Other installation requirements as for RA90.

3.13 INSTALLATION OF LOW VOLTAGE CONTROL CABLES

.1 Install low voltage control cables in conduit.

.2 Ground control cable shield.

3.14 INSTALLATION OF INSTRUMENTATION CABLES

.1 Install instrumentation cables in conduit.

.2 Ground cable shield.

3.15 INSTALLATION IN EQUIPMENT

.1 Group and lace-in neatly, wire and cable installed in switchboards, panel boards, cabinets, wireways and other such enclosures.

3.16 TERMINATIONS

.1 Terminate wires and cables with appropriate connectors in an approved manner.

3.17 MOTOR CONNECTIONS

.1 Flexible connections to motors shall not exceed 2m unless authorized in writing by Departmental Representative.

3.18 IDENTIFICATION

.1 Provide cable identification on all cables.

.2 Wire in conduit #2 AWG and smaller shall have solid coloured insulation, colour coded as listed below.

.3 Wire in conduit #1/0 AWG and larger and single conductor cables shall be identified at each outlet box and termination with a 150mm band of coloured vinyl tape of the appropriate colour. Neutral and ground conductors shall be identified. Paint or other means of colouring the insulation shall not be used.

.4 Colour code wire in conduit and single conductor cables as follows unless otherwise shown on the drawings:

Three Phase Systems:			**Single Phase Systems:**		
Phase A	-	red	Phase A	-	red
Phase B	-	black	Phase B	-	black
Phase C	-	blue	Neutral	-	white
Neutral	-	white	Ground	-	green
Ground	-	green			

.5 Maintain phase sequence and colour coding throughout project.

.6 Use colour-coded wires in communication cables, matched throughout the system.

.7 Identify control conductors in motor control equipment, contactors, fire alarm panels, etc. with mylar/cloth wire markers.

.8 Identification text to include panel name, wire number and wire type (A, B, C, N or G). Identification to be independent of circuit numbers to allow phase balancing.

.9 Provide identification on cables at:

.1 Inside distributions/panelboards.

.2 Inside device boxes or at terminations.

.3 Wide junction boxes where joints are made.

.10 Distribution feeders to be identified as follows:

.1 Color code of feeder phase shall appear on every cable in two locations at any distribution; once inside the distribution enclosure near the cable termination and once outside the distribution enclosure, in a visible location near the enclosure.

.11 Color code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc., by means of colored insulation or

markers. Use markers of a type not subject to aging or deterioration through heating, drying or easy erasure. Color code in accordance with Rule 4-036 of the CEC. Phasing to be ABC, left, centre, right respectively.

.12 Demonstrate to the Departmental Representative that each wire has been clearly identified with wire markers where requested.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.41-M1987(R1999), Grounding and Bonding Equipment.

Part 2 Products

2.1 CONNECTORS AND TERMINATIONS

.1 Copper, long barrel or short barrel compression connectors as required, sized for conductors.

.2 Provide compression lugs for feeder cables. Set screw connectors not allowed.

Part 3 Execution

3.1 INSTALLATION

.1 Install terminations and splices in accordance with component installation specifications and instructions.

.2 Bond and ground as required.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association:

.1 CAN/CSA C22.2 No. 41 Grounding and Bonding Equipment.

Part 2 Products

2.1 EQUIPMENT

.1 Ground equipment: to CAN/CSA C22.2 No. 41

.2 Clamps for grounding of conductor: size as required to electrically bond to underground water piping.

.3 Grounding conductors: bare stranded copper, tinned, soft annealed, minimum size #3/0.

.4 Ground bus: copper; minimum 300mm long, 25mm high and 6mm thick with pre drilled holes, complete with 2700V insulated supports, fastenings, connectors.

2.2 ACCESSORIES

.1 Non-corroding, necessary for complete grounding system, type, size, material as required, including:

.1 Grounding and bonding bushings
.2 Protective type clamps
.3 Bolted type conductor connectors
.4 Thermit welded type conductor connectors
.5 Bonding jumpers, straps
.6 Pressure wire connectors

.2 Copper alloy castings with silicon bronze bolts, nuts and washers for connecting pipe, tube, cable, flat bar and special bus shapes.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Ensure that all components make good contact at connections to form a continuous metallic ground through the system. Torque bolts in accordance with equipment installation recommendations.

.2 Ensure that contact surfaces are free of grease, oil, paint, primer and similar surface coverings. Clean all conductor contact surfaces thoroughly before installation by scratch brushing until bright and shiny.

.3 Install complete permanent, continuous system and circuit grounding systems including electrodes, conductors, connectors and accessories to conform to code. Where EMT is used, run ground wire in conduit.

.4 Install connectors in accordance with equipment installation recommendations.

.5 Protect exposed grounding conductors from mechanical injury.

.6 Use mechanical connectors for grounding connections to equipment provided with lugs.

.7 Soldered joints not permitted.

.8 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.10 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end as necessary and run separate ground conductor.

3.2 SYSTEM AND CIRCUIT GROUNDING

.1 Where not specified otherwise, size of bonding and grounding conductors to be in accordance with Table 16 of the Canadian Electrical Code.

3.3 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to the following: frames of motors, starters, control panels, distribution panels.

3.4 FIELD QUALITY CONTROL

.1 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative. Record readings and place copy in maintenance manual.

.2 Perform tests before energizing electrical system.

.3 Disconnect ground fault indicator during tests.

END OF SECTION

Part 1 General

.1 Not used.

Part 2 Products

2.1 SUPPORT CHANNELS

.1 U shape, galvanized steel, size 41mm x 41 mm, 2.5mm thick, surface mounted, suspended or set in poured concrete walls and ceilings as required.

.2 Support equipment to be of type and size required to withstand the fire rating where used (rack hangers, rods, anchors).

Part 3 Execution

3.1 INSTALLATION

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.

.2 Secure equipment to poured concrete with cast in or expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation. Provide additional support where required.

.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.6 Fasten exposed conduit or cables to building construction or support system using straps.

- .1 One-hole steel straps to secure surface conduits and cables 32mm and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 32mm.
- .3 Beam clamps to secure conduit to exposed steel work.

.7 Suspended support systems.

- .1 Support individual cable or conduit runs with 6mm diameter threaded rods and spring clips.
- .2 Support two or more cables or conduits on channels supported by 10mm diameter threaded rod hangers where direct fastening to building construction is impractical.

.8 For surface mounting of two or more conduits use U-channels at 1500mm on centre spacing.

.9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.11 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.12 Do not use supports or equipment installed for other equipment for conduit or cable support except with permission of Departmental Representative.

.13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with equipment installation recommendations.

.14 Install continuous vertical channel supports for conduits in utility service rooms and mechanical room.

.15 Where conduit and cable runs are installed on support systems, they shall run so as to be as inconspicuous as possible. Coordinate support system with equipment of other trades to ensure proper installation of equipment. Run support system paths perpendicular or parallel to building lines.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CAN/CSA C22.2 No. 40 Cutout, Junction and Pull Boxes.

.2 CAN/CSA C22.2 No. 75 Splitters.

Part 2 Products

2.1 SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS - GENERAL

.1 ANSI 61 grey polyester powder coat finish inside and out over phosphatized steel.

.2 Gasketed and waterproof for wet and damp locations.

.3 Locate splitters, junction and pull boxes as needed for each system.

2.2 JUNCTION AND PULL BOXES

.1 Code gauge sheet steel, welded construction.

.2 Screw-on hinged flat covers.

.3 For flush mounting, covers to overlap box by 25mm minimum all round with flush head cover retaining screws.

Part 3 Execution

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Supply all pull boxes and junction boxes shown on the drawings and as required for the installation.

.2 Install in inconspicuous but accessible locations, above removable ceiling or in electrical rooms, utility rooms, or storage areas. Advise Departmental Representative of locations prior to installation.

.3 Size in accordance with Rule 12-3036, Canadian Electrical Code, as a minimum. Sizes shown on the drawings may be adjusted to suit available space. Review with Departmental Representative where necessary.

.4 Install terminal block as Type T cabinets.

.5 Where junction and pull boxes are not indicated, install pull boxes so as not to exceed 30m of conduit run between pull boxes.

.6 Install junction and pull boxes clear of all mechanical duct work and piping.

3.2 IDENTIFICATION

.1 Install size 2 identification labels indicating system name and system voltage (where voltage is applicable).

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CAN/CSA C22.2 No. 18.1 Metallic Outlet Boxes.

.2 CSA C22.1 Canadian Electrical Code, Part 1.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES - GENERAL

.1 Minimum size of boxes to be in accordance with Canadian Electrical Code, Section 12.

.2 Boxes to be hot dip galvanized to ASTM a924(M), designation zinc coating Z180 (G60).

.3 102mm square or larger outlet boxes as required for special devices.

.4 Provide multi-gang boxes where wiring devices are grouped.

.5 Provide blank cover plates for boxes without wiring devices.

.6 Provide barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

.1 Hot dipped galvanized steel device boxes for flush installation, minimum size 102mm square with extension and plaster rings as required.

.2 Hot dipped galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit.

.3 102mm square or octagonal outlet boxes for lighting fixture outlets.

.4 102mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3 MASONRY BOXES

.1 Hot dipped galvanized steel masonry single and multi-gang boxes, 89mm deep, for devices flush mounted in block walls.

.2 Provide 64mm deep boxes only when wall thickness does not allow 89mm box to be used.

2.4 CONCRETE BOXES

.1 Hot dip galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 CONDUIT BOXES

.1 Cast feraloy boxes, 64mm deep, with factory-threaded hubs and mounting feet for surface mounting of wiring devices and for use in electrical or mechanical rooms.

.1 Provide 43mm deep boxes only when installation does not allow 64mm boxes to be used.

.2 Not approved for telecommunications use.

2.6 SECTIONAL BOXES

.1 Sectional boxes shall not be utilized.

2.7 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

.1 Install all outlets flush, plumb and square with building lines.

.2 Surface mount above suspended ceilings and in mechanical and electrical rooms.

.3 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry wall to achieve net openings for all boxes.

.4 Where a two gang box is required for single gang device, provide special plate with device opening in one gang and blank second gang.

.5 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.6 Use plaster rings to correct depth. Use 32mm on concrete block.

.7 Installation to be in accordance with Rules 12-3000 to 12-3036, Canadian Electrical Code, “Installation of Boxes, Cabinets, Outlets and Terminal Fittings”. Minimum box size to be in accordance with Rule 12-3036 and Table 23, Canadian Electrical Code, “Number of Conductors in Boxes”. Use more than one outlet box where the number of joints exceeds the requirements for the boxes specified.

.8 Support boxes independently of connecting conduits.

.9 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.10 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.11 Provide correct size of openings in boxes for conduit and cable connections. Reducing washers are not allowed.

.12 Align outlets that are installed in the same general location so that they are centered.

.13 Boxes installed in walls with air barriers require vapour boxes. Apply acoustical sealant around conduits and cables which penetrate vapour boxes.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)

- .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
- .2 CAN/CSA C22.2 No. 45, Rigid Metal Conduit.
- .3 CAN/CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .4 CAN/CSA C22.2 No. 83, Electrical Metallic Tubing.
- .5 CAN/CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

1.2 LOCATION OF CONDUIT

.1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

.2 Contractor shall produce layout sketches of conduit runs through mechanical and electrical service areas to avoid any conflict with other construction elements and to determine the most efficient route to run conduit.

1.3 FIRE RATING

.1 Fire rating of combustible conduits shown are minimum required. Provide conduit of fire rating as required by code.

Part 2 Products

2.1 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 32mm and smaller. Two hole steel straps for conduits larger than 32mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 U-channel type supports for two or more conduits at no more than 2M O/C spaced as per code and equipment installation recommendations, whichever is closer.

.4 Threaded rods, 6mm diameter, to support suspended channels.

.5 Perforated metal and field fabricated hangers and supports not acceptable.

2.2 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 Factory "ells" where 90º bends are required for 27mm and larger conduits.

.3 Steel set screw connectors and couplings. Insulated throat liners on connectors.

.4 Raintight connector fittings complete with O-rings for use on weatherproof or sprinkler proof enclosures. Raintight couplings to be used for surface conduit installations exposed to moisture. Raintight connectors shall be used for all top entries to panels, contactors, motor control starters and centres, transformers, etc.

2.3 EXPANSION FITTINGS FOR RIGID METAL AND PVC CONDUIT

.1 Weatherproof expansion fittings suitable for 200mm linear expansion.

.2 Watertight expansion fittings suitable for linear expansion and 19mm deflection in all directions.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

.4 With internal bonding assembly for metallic conduits.

2.4 FISH CORD

.1 Polypropylene, minimum 200 kg strength, UV resistant.

2.5 CONDUIT - GENERAL

.1 Minimum conduit size shall be 21mm unless otherwise indicated.

2.6 ELECTRICAL METALLIC TUBING (EMT)

.1 Conduit: electrical metallic tubing with wall thickness less than rigid conduit, hot dipped galvanized with corrosion resistant and friction reducing coating on inside, to CAN/CSA C22.2 No. 83.

.2 Connectors and fittings: in dry locations, steel or malleable iron wet concrete tight, set-screw fasteners with insulated throats complete with expansion joints as required. Die cast connectors are not permitted.

2.7 FIRE ALARM EMT

.1 Provide red EMT conduits for fire Alarm system.

.2 Characteristics same as for EMT except bright red coating applied to exterior of conduit.

.3 Label EMT as per specifications.

.4 Provide sample of labelling to Departmental Representative for final approval prior to installation.

2.8 RIGID METAL CONDUIT

.1 Conduit: rigid galvanized steel, heavy wall, with threaded joints and connections to CAN/CSA C22.2 No. 45.

.2 Connectors: in dry locations steel or malleable iron, insulated throat type bushings inside, enclosures, lock nuts outside enclosures. In locations subjected to moisture interior and exterior: liquid and dust tight with insulated throat.

.3 Rigid conduit fittings: outlet boxes, junction boxes, LB's and other fittings cast metal with factory applied epoxy paint.

.4 Expansion joints: rigid conduit type with external bonding jumper.

.5 Ground bushing: threaded type with insulated throat.

2.9 RIGID PVC CONDUIT

.1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride to CAN/CSA C22.2 No. 211.1.

.2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied and recommended by conduit installation instructions.

.3 Fire rating: FT4.

.4 Expansion joints: as supplied and recommended by conduit installation instructions, complete with two O-rings.

2.10 FLEXIBLE CONDUIT

.1 Conduit: flexible metal conduit, spirally wound, interlocked zinc coated steel strip which may be easily bent without use of tools to CAN/CSA C22.2 No. 56.

.2 Connectors: steel slip-proof, complete with insulated throat.

2.11 LIQUID TIGHT FLEXIBLE CONDUIT

.1 Conduit: construction same as flexible conduit, with liquid-tight PVC outer jacket to CAN/CSA C22.2 No. 56.

.2 Connector: type providing seal to conduit jacket and positive ground to interior of conduit, with high pull-out resistance and insulated throat, straight or angles.

Part 3 Execution

3.1 CONDUIT INSTALLATION

.1 Provide a separate raceway for each electrical system.

.2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.3 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.4 Do not surface mount conduits in other areas unless specifically indicated.

.5 Wiring homeruns to panel boards and main branch circuit wiring runs in ceiling space to be run using TECK or in conduit. Wiring drops from conduit systems to light fixtures shall not run horizontally more than 1.8m from conduit system junction boxes in ceiling space.

.6 Type AC90 armoured cable (Bx) with screw type connectors shall be used for connections from conduit systems to luminaires in accessible ceilings and stud partitions or to magnetic door holders. Maximum length of AC90 armoured cable for connections to luminaires mounted in stud partitions shall be 1.5m. Type BX cable shall not be used for any other application.

.7 Armour of TECK cable shall be grounded via an aluminum plate at the supply end and isolated via an insulating plate at the load end of the cable.

.8 Use electrical metallic tubing (EMT) above 2.4m and in areas where it will not be subjected to physical damage.

.9 Rigid galvanized steel conduit shall be used where exposed to damage, in wet or hazardous locations or under floor slabs where shown on the drawings.

.10 Use Rigid PVC Conduit in poured concrete, in duct banks, in areas subject to intermittent or continuous moisture (i.e. coolers, etc.). These areas may not necessarily be shown on the drawings.

.11 Use flexible metal conduit in dry locations for connection to motors movable partitions not served by a solid raceway, fluorescent fixtures recessed in T-bar ceilings, suspended fixtures, transformers and equipment subject to movement or vibration, A Motor connections and connections to transformers in damp locations to be liquid-tight.

.12 All flush mounted branch circuit panelboards shall have two 27mm spare conduits stubbed out and extended into accessible ceiling space so that future circuits can be installed without damaging walls or finishes surrounding the panel.

.13 The length of any conduit run shall not exceed 30m and no conduit run shall have more than four 90º bends before a pull box is required. Pull boxes to be installed in accessible ceiling space. Conduits shall be supported within 300mm of entering any junction box, pull box, cabinet or panel board.

.14 Conduit to be sized as per Canadian Electrical Code. Note that the sizes of branch circuit conductors scheduled and/or specified on the drawings are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with Canadian Electrical Code. Where conductor sizes are increased to suit voltage drop requirements, increase the conduit size to suit at no extra cost.

.15 Seal around all conduit penetrations through floors to ensure penetrations are watertight.

.1 Sealant Maximum VOC Content: 250g/L (less water)

.16 Install conduit sealing fittings in hazardous areas. Fill with compound.

.17 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter. Radius of bend shall be not less than 600mm.

.18 Mechanically bend steel conduit over 21mm diameter.

.19 Install fish cord in empty conduits.

.20 Install expansion joints where conduits cross building expansion joints.

.21 Ream conduit ends to remove all burrs.

.22 Seal to air barriers conduits which penetrate barrier.

.1 Sealant Maximum VOC Content: 250g/L (less water)

.23 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.24 Dry conduits out before installing wire.

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 within 300mm of flues, steam or hot water lines.

.7 When a conduit can be run surface, it shall be primed and painted with two coats of paint to satisfaction of Departmental Representative.

3.3 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings unless otherwise indicated.

3.4 CONDUITS IN CAST-IN-PLACE CONCRETE

.1 Installation of conduits in concrete floor slabs is acceptable for feeding free-standing equipment only. Installation of conduits in concrete floor slabs shall not be permitted for any other application.

.2 Obtain approval from Departmental Representative:

.1 Where conduits are spaced closer than 3 diameters.

.2 For conduits greater than 53mm diameter.

.3 Where conduits must be run less than 8 diameters from columns.

.3 Locate to suit reinforcing steel. Install in centre one third of slab. Do not strap directly to parallel reinforcing steel (and reduce concrete bond). Strap to reinforcing steel perpendicular to conduit.

.4 Protect conduits from damage where they stub out of concrete.

.5 Install sleeves where conduits pass through slab or wall.

.6 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.

.7 Do not place conduits is slabs in which slab thickness is less than 4 times conduit diameter.

.8 Encase conduits completely in concrete with minimum 50mm concrete cover.

.9 Organize conduits in slab to minimize crossovers.

3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

.1 Installation of conduits in cast-in-place slabs on grade is acceptable for feeding free-standing equipment only. Installation of conduits in cast-in-place slabs on grade shall not be permitted for any other application.

3.6 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.7 GROUNDING

.1 Where current carrying conductors are installed in raceway, provide ground wire of equal size.

.2 Where non-current carrying/telecommunication conductors are installed minimum ground wire size #6 AWG.

.3 Ensure raceways are large enough to accommodate additional (ground) wire.

3.8 INSTALLATION OF EMT CONDUIT

.1 Use EMT strictly in accordance with Rules 12-1400 to 12-1410 inclusive of CEC.

3.9 INSTALLATION OF FIRE ALARM EMT

.1 Installation to be as for EMT.

.2 Touch-up all scratches and damages to red EMT coating with matching red paint upon completion of project to satisfaction of Departmental Representative.

.1 Maximum VOC Content: 50g/L (less water) for flat paint, or 150g/L (less water) for non-flat paint

3.10 INSTALLATION OF RIGID METAL CONDUIT

.1 Touch up damage to epoxy finish on rigid conduit fittings with touch-up paint. Paint exposed threads on rigid conduit with epoxy paint.

.1 Maximum VOC Content: 150g/L (less water) for non-flat paint

3.11 INSTALLATION OF RIGID PVC CONDUIT

.1 Use strictly in accordance with Rules 12-1100 inclusive of CEC.

.2 When not encased in concrete:

.1 Provide expansion joints and follow manufacturer’s recommendations and code requirements with respect to expansion/contraction, particularly where temperature variations are anticipated.

.2 Install conduits loosely with straps and clamps to allow movement.

3.12 INSTALLATION OF LIQUID TIGHT FLEXIBLE CONDUIT

.1 Provide a separate ground conductor within flexible conduit, bonded to motor frames and system ground.

.2 Install conduit to prevent liquids draining to connectors.

3.13 WORKMANSHIP

.1 Install all conduit and wiring concealed, except where specifically noted otherwise. Install conduit in furred spaces or recessed in block or masonry walls. Do not recess conduits in columns or concrete walls, except as noted, without permission. Where conduit is necessary to be run exposed, run parallel to building lines.

.2 Where metal conduit is placed in concrete, screw up joints tight and paint joints with sealant paint. Before concrete is poured, tightly pack outlet boxes with paper and cap open ends of conduit to prevent concrete intrusion. At junction between exposed conduit and concrete, paint conduit before concrete is poured.

.3 Take extreme care and ream the ends of all conduits to ensure a smooth interior finish that will not damage the insulation of the wires. Ensure electrical continuity in all conduit systems.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Suitably identify with lamacoid nameplates all pieces of electrical equipment such as lighting, power and distribution panels, power conditioner unit, panelboards, motor control centre, telephone panels, transformers, disconnect switches, contactors, motor starters, control devices, pull boxes, exit lights, splitters, system panels, receptacle coverplates and all equipment connected direct to the power supply.

1.2 NAMEPLATES AND PANEL DIRECTORIES

.1 Laminated phenolic nameplates with engraved white letters on:

.1 Black for normal power.

.2 Red for emergency power.

.3 Blue for UPS power

.2 Unless specifically indicated otherwise lettering size to be as follows:

.1 Lamacoid nameplates: 3mm thick plastic engraving sheet, black or red faced, white core, mechanically attached with shelf-tapping screws or split rivets, unless otherwise specified. 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 Label receptacle and other outlet box coverplates: 5 mm minimum height (.76 mm inscription width).

.3 Motor control centre identification lamacoid (top one), large sub-distribution panel identification lamacoid (top one), all main distribution identification lamacoids: 100 mm minimum height (1.52 mm inscription width).

.4 Breakers:

.1 Sub-distribution panels: 7 mm minimum height. May be reduced to 5 mm if there are space restrictions.

.2 Panelboards: 5 mm minimum height. May be reduced to 3 mm if there are space restrictions.

.5 Others: 7 mm minimum height (1.02 mm inscription width) when less than 2500 mm above floor; 10 mm minimum height (1.52 mm inscription width) when more than 2500 mm above floor.

.3 Prior to nameplate fabrication, submit to the Departmental Representative for approval a copy of all panel directories with a list stating exact wording and fabrication details for all nameplates.

.1 Submit one complete package, including details for all equipment and devices connected to or part of the electrical distribution.

.2 Submission to be received by Departmental Representative a minimum of 2 weeks prior to schedule completion of the work.

.4 Submit panel directories in electronic format to accommodate future revisions.

.1 Submit copies of all 'as-built' panel directories for all new panel boards worked on.

.5 Use Departmental Representative's building and location codes to provide permanent equipment identification. Confirm permanent building and location codes with Departmental Representative prior to making name plates and directories.

.6 In each maintenance/operating manual, include a copy of all panel directories and nameplate listings which were reviewed by Departmental Representative, including any changes or corrections prior to lamacoid fabrication. Nameplate listing schedule shall have exact description of what appears on installed lamacoid, for all lamacoids (excluding receptacle lamacoids) installed by Division 26.

.7 Co-ordinate names of equipment and systems with mechanical to ensure consistency.

.8 All nameplates and panel directories to be installed and 100% complete prior to commissioning.

1.3 PANELBOARD AND DISTRIBUTION CENTRE IDENTIFICATION

.1 Provide a typewritten data card enclosed in a clear plastic pouch attached inside the door of each panel board or distribution centre. Information listed on the data card shall include the following:

.1 Panel board or distribution centre title and code number.

.2 Supply feeder panel board or distribution centre title and code number, slot number and location (Departmental Representative's building and location code).

.3 The following information for each circuit:

.1 Circuit # and location(s) (Departmental Representative's building and location code).

.2 Circuit function i.e. lighting, receptacles, equipment (state equipment name), spare, etc.

.2 When a lighting and/or receptacle panel board sub-feeds other lighting and/or receptacle panel boards, supply and install a lamacoid on supply feeder panel board door (inside) below directory. Information on lamacoid shall identify the following:

.1 Circuit # and location(s) (Departmental Representative's building and location code).

.2 Panel board identification of panel being sub-fed. This lamacoid identification and directory shall be identical. Rivet or screw lamacoid to panel board door. Letter size shall be minimum 5 mm high.

.3 Insert a copy of each data card into each maintenance/operating manual.

.4 Panel and circuit identification (examples provided):

.1 Panel directory identification:

.1 Near the top of the directory, provide the following information: PANEL: A (panel identification code no.) 120/208V/3PH/4W (panel voltage, # of phases and wires) FED FROM SD-2A IN B-005 (origin of feeder).

.2 If panel is connected to emergency power, indicate: EMERG. POWER: EA.

.2 Receptacle colour and circuiting:

.1 Emergency power circuits: All receptacles and switches to be red.

.2 UPS power circuits: All receptacles to be blue.

.3 Normal power circuits: All receptacles to be white.

.3 Sample panel directory:

Panel: A

120/208V/3PH/4W

Fed from SD-2A in B-005

Circuit	**Three Phase**		**Circuit**
Recept 609	1A	22A	Recept 609
Recept 615, 615A	2B	23B	Recept 615A
Recept 615A	3C	24C	Console 604A
Recept 609A	4A	25A	Console 604B
Recept 609	5B	26B	Console 604C
Recept 615	6C	27C	Recept 604A, B
Lights 615A	7A	28A	Recept 604C
Lights 609B	8B	29B	Recept 604C
Recept 604A, 604B,	9C	30C	Spare

Recept ON-604A	10A	31A	UnitHeater UH-1
Recept 604B	11B	32B	UnitHeater UH-1
Recept 602	12C	33C	UnitHeater UH-2 604B, 604
Lights 602, 604	13A	34A	UnitHeater UH-2
Lights 604	14B	35B	UnitHeater UH-3 604A
Fan F-19	16A	37A	Spare
Sup. Fan F-18	17B	38B	Spare
Sup. Fan F-18	18C	39C	Spare
Fan Coils FC-1	19A	40A	Space
Recept 609A	20B	41B	Space
Recept 609A	21C	42C	Space

The contractor is to supply a sample of the proposed panel designations to the Departmental Representative for approval, prior to all labeling.

1.4 OTHER EQUIPMENT IDENTIFIED BY NAMEPLATE

.1 Splitters and pullboxes: Indicate their function and characteristics (equipment description and location where fed from and what it feeds). 401-D/38

1.5 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code of feeder phase shall appear on every cable in two locations at any distribution; once inside distribution enclosure near cable termination and once outside distribution enclosure, in visible location near enclosure.

.2 Junction boxes with power wiring, all circuits inside the box shall be identified on the inside of the cover plate with permanent marker.

.3 Provide self-sticking vinyl stick-on conduit markers for the following systems. Markers to be:

.1 28.6 mm x 114.3 mm for 25 mm conduit and larger.

.2 12.7 mm x 57.2 mm for conduit under 25 mm.

.4 Space markers 10 metres on centres maximum for exposed conduits and conduits in accessible ceiling spaces and, in addition, attach markers before and after all barriers, where conduits pass through closets, cupboards, stairwells, etc., and adjacent to all panels, cabinets, pullboxes and access fittings. Markers to be laminated mylar with orange background and black letters. Identify systems as follows:

NORMAL POWER
EMERGENCY POWER
UPS POWER
FIRE ALARM
CONTROL WIRING
A.T.S. CONTROLS
DC EMERG. LIGHTING
GROUND CONDUCTOR
Others: Check with Departmental Representative. All conduit systems shall be identified.

.5 All stick-on conduit markers must be installed during installation of related conduit systems, not after installation of complete conduit systems.

.6 Do not apply stick-on conduit markers onto exposed raceways.

Part 2 Products

.1 Not used.

Part 3 Execution

.1 Not used.

END OF SECTION

Part 1 General

.1 Not used.

Part 2 Products

2.1 NAMEPLATES

.1 Lamacoid:

.1 Black with white lettering for normal power

.2 Red with white lettering for emergency power

Part 3 Execution

3.1 MOTOR SURVEY

.1 Make a complete survey of all electrical motors. Number every motor, both single phase and three phase. Label every motor to show the motor number, the motor name and location of the starter. Example: 'Motor #41 Exhaust Fan #3, Starter in MCC#1'. Label every starter to show motor it controls and, where motor is not in same area, give location of motor. Identify voltage and panel being fed from.

.2 For every motor and starter, fill in the form illustrated herein. List each motor on a separate 200 x 300 mm page. Provide three typed copies of this list in each maintenance manual prior to substantial completion. Where motors are controlled by more than one control device, prepare an accurate elementary diagram of the controls on a 200 x 300 mm sheet. Forms and diagrams are to be neatly typed and drafted.

3.2 NAMEPLATES

.1 Securely screw to equipment, so as to be clearly visible.

SURVEY OF MOTORS

Motor Name and Number: _____

HP: _____ Amps: _____ Volts: _____ Phase: _____

Service Factor: _____

OPERATING CONDITIONS

No Load Amps: Phase A: _____ Phase B: _____ Phase C: _____

Operating Voltage: A to B: _____ B to C: _____ C to A: _____

Overload Size: _____

Wire Size: _____

Special Controls and Remarks (Thermistor and Relay Type, Capacitors, etc.)

_____

_____

_____

_____

_____

_____

_____

PREPARED BY: _____ DATE: _____

END OF SECTION

Part 1 General

1.1 REQUIREMENTS

.1 Provide a complete system of power wiring to motors and controls.

.2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under this Contract. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied by other Divisions.

.3 Where control wiring diagrams are shown illustrate typical control circuits applicable to the equipment. Verify all control circuits with the equipment and make any corrections that may be required.

.4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc. necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.

.5 Do not operate motors and controls until approval is obtained from the Departmental Representative.

.6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on other Division drawings and specifications. Where necessary, obtain conduit locations from drawings & shop drawings. The complete list of motors may not be shown on the electrical drawings.

.7 Contractor to ensure mechanical shop drawings are reviewed and coordinated with final equipment nameplate, including HP/kW/AMP sizes. All indicated motor are to be manufactured at the specified voltage, no transformation to be provided. No 480V equipment allowed.

.8 Assist in placing in operation all mechanical equipment having electrical connections.

.9 Provide three phase starters with primary and secondary fused 120 volt control transformers and overload relays.

.10 In general, wiring for freezestats, EP switches P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating, ventilating and air conditioning equipment will be by Division 23, from control panels supplied and installed by Division 23. Provide terminations in starters and MCC's for control wiring, so that starter control circuits may be extended by the Contractor. Where 120 volt power is required for mechanical equipment, i.e.: for roll type filters, refrigerated aftercoolers, control cabinets, etc., wiring to the equipment terminals is the work of Division 26. Division 26 to wire all 120V AHU internal lighting and receptacles, condensers and rooftops weatherproof outdoor receptacles.

Part 2 Products

2.1 3Ø MOTOR DISCONNECT SWITCHES

.1 Industrial Type "A" having quick-make, quick-break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC-4 enclosures outdoors, EEMAC-1 indoors and drip proof shield watertight for areas exposed to sprinklers. Switches to be kW rated, Square "D" Type A heavy duty.

2.2 120V & 208V 1Ø DISCONNECT SWITCHES

.1 Manual starter without overload relay.

Part 3 Execution

3.1 GENERAL

.1 For all motors, provide disconnect switches adjacent to the motors.

.2 Wall mount disconnects adjacent to equipment or floor mount at motor locations. Wall mounted disconnects to be 1400 mm above floor.

3.2 CONTROL CABINETS & CONTROLS

.1 Verify the location of all control cabinets, and provide power wiring to each cabinet from the nearest electrical panel where not specifically shown from a particular panel.

.2 Power wiring for mechanical equipment is the responsibility of Division 26. Provide circuits and wiring to suit the controls requirements. All control power wiring requirements may not be specifically shown on the drawings.

.3 All control wiring shall be run in conduit. Coordinate with Contractor.

3.3 COMMISSIONING

.1 Refer to Section 01 91 13 – Commissioning General Requirements.

.2 Do not start motors until the supplier of the equipment has verified that the electrical connection has been made in accordance with the nameplate information.

.3 Extreme caution must be taken in connection of motors with nameplates having multiple connection diagrams i.e.: WYE-DELTA Start, MULTISPEED.

.4 Be responsible for replacement of motors or other equipment damaged by starting-up prior to being checked.

END OF SECTION

Part 1 General

.1 Not used.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Fusible and non-fusible disconnect switch in NEMA 2 enclosure for interior sprinkler proof application, unless otherwise indicated.

.2 Provision for padlocking in on-off position.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Fuses: size as required.

.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 Cover viewing window to allow visual verification of “On-Off” status.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification.

.2 Indicate name of load controlled on size 4 nameplates.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses only where specifically indicated.

.2 Install circuit disconnect switches where indicated or where required by code.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures, and Section 26 05 00 – Common Work Results – Electrical.

.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.

Part 2 Products

2.1 MATERIALS

.1 Starters: EEMAC (Electrical and Electronic Mfg. Association of Canada) standard "E14-1".

- .1 Half size starters not acceptable.

2.2 MANUAL MOTOR STARTERS

.1 Single or Three phase manual motor starters of size, type, rating, and enclosure type as required, with components as follows:

- .1 Switching mechanism, quick make and break.
- .2 One or Three overload heaters, manual reset, trip indicating handle.
- .3 Horsepower rated.

.2 Accessories:

- .1 Toggle switch.
- .2 Indicating lights.
- .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

.1 Magnetic and combination magnetic 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 Power and control terminals.

.4 Wiring and schematic diagram inside starter enclosure in visible location.

.5 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include motor circuit protector as follows:

.1 Breakers to be specifically designed for motor applications, with adjustable trips fixed with a locking pin.

.2 Interrupting rating to suit available RMS sym.

.3 Size trip as a function of motor nameplate FLA, and in accordance with manufacturer's recommendations.

.4 Locking in "OFF" position with up to 3 padlocks.

.5 Locking in "ON" position.

.6 Independent locking of enclosure door.

.7 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 Oil tight selector switches: HOA labelled.

.2 Oil tight indicating lights: red running push to test lamps.

.3 1-N/O and 1-N/C spare auxiliary contacts.

2.4 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with 120 volt secondary voltage unless indicated otherwise, complete with primary and secondary fuse installed in starter.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.5 FINISHES

.1 Enclosures to be sprinkler proof.

2.6 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification.

.2 Manual starter designation label, black plate, white letters, size 1, engraved lamacoid.

.3 Magnetic starter designation label, black plate, white letters, size 3, engraved lamacoid.

2.7 RELAYS

.1 Install protective relays where motors are provided with thermistors.

Part 3 Execution

3.1 STARTER VERIFICATION

.1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:

- .1 Check of control circuits.
- .2 Verify that overload relay installed is correctly sized for motor used.
- .3 Current test overload relay, to ensure that relay trips at its prescribed rating (use a low-voltage high current test set), or equivalent.
- .4 Visual inspection of breakers and contactors.

.2 Measure motor amps under load conditions and compare with full load amps and motor service factor. Report any excessive imbalance. Measure voltage and motor terminals. Voltage to be approximately 575 to 590 volts.

.3 Record settings of MCP and relays, etc. and include in Operation and Maintenance manual.

3.2 OVERLOAD RELAYS

.1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during start-up to ensure motor operation is satisfactory and relays provide proper protection. For side inlet and other long acceleration time motors, provide special overload relays to suit the start-up condition. Provide equipment curves and data sheets where necessary to provide supporting data for motor protection and to perform a co-ordination study.

.2 Adjust relay settings for motors provided with thermistors

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Electrical Code (CEC)

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.

.3 Institute of Electrical and Electronics Engineers (IEEE)

.1 IEEE 518-2 - Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources

.2 IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.2 SUBMITTALS

.1 In accordance with Section 01 33 00 and Section 01 78 00.

.2 Submit the following additional information:

.1 Dimensions and weights of drives including enclosure.

.2 Catalogue and technical data.

.3 Control and schematic drawings indicated all external connections and devices.

.4 Instruction manuals for installation and programming, including start-up configuration data.

1.3 VARIABLE FREQUENCY DRIVES (VFD)

.1 General:

.1 Drives shall be capable of constant torque as specified and as required by the application.

.2 Selection of VFD shall be coordinated with manufacturer of the equipment and motor to be controlled to ensure compatibility and optimum performance.

.3 VFD shall be housed in NEMA 12 rated enclosure suitable to the location where it is installed. All drives located indoors shall be sprinkler proof.

.4 The enclosure and installation location shall be selected as to minimize RFI and EMI emissions.

.5 Drives shall comply with FCC and CRTC regulations with respect to emissions and radio interference.

.6 Drives shall be UL, C-UL listed and CSA approved.

.7 Drives shall include all necessary devices, relays, protective devices, wiring and programming to form a complete working system. The adjustable frequency drive shall convert three phase, 60 Hz utility power to an adjustable frequency output for speed control from 0 - 100% of base speed.

.8 The drive must be modifiable to accept standard input voltages accurately.

.9 The adjustable frequency control shall be designed specifically for variable speed fan and pump applications.

.10 All products supplied as part of drive including, but not limited to: disconnect switches, circuit breakers. Disconnect switches, motor starters shall be NEMA rated.

.2 Filters and Reactors

.1 General: The VFD shall meet with the First Environment restricted level of EN61800-3, through the use of EMI/RFI filters.

.2 Provide filters, 5% reactors and other devices required on the load side of the variable frequency drive to minimize RFI, EMI and harmonic emissions from the drive.

.3 Provide filters, reactors and other devices required on the line side of the variable frequency drive to protect the drive from interference and emissions that will compromise its operation.

.3 Basic Design:

.1 Micro processor based pulse width modulation, design employing IGBT technology to convert three phase AC to a fixed DC voltage.

.2 A constant speed displacement power factor of .95 shall be maintained at all speeds and rated loads.

.3 Insulated grade bipolar transistors in the invertor section converts a fixed DC voltage to a three phase adjustable frequency output.

.4 Drive output employ a high carrier frequency to ensure quiet motor operation.

.4 System Features

.1 Drive inline/bypass/isolation contactor.

.2 Bypass overload.

.3 Mechanical interlock between bypass and full voltage bypass.

.4 Four position selector switch (VFD / VFD TEST/ BYPASS / ISOLATION)

.5 Drive input circuit breaker, lockable in the open position.

.6 Thermal overloads.

.7 Thermistor input for motor overtemperature protection.

.8 Fused control power transformer.

.9 Diode or fully gated bridge on input.

.10 DC bus inductor on all VFD rated at 7.5 hp and larger.

.11 Auxilliary contacts as follows:

.1 Drive alarm.

.2 Drive speed.

.3 Control power on.

.4 Drive fault.

.5 Drive run.

.12 Communications to include RS232/422/485 and industry standard protocols including BACnet.

.5 Control Panel:

.1 Drive status indicators on the control panel include multi-point status and diagnostics.

.2 Adjustments accessible by means of keypad switches:

.1 Acceleration/deceleration time: Independently adjustable from approximately 2 to 300 seconds.

.2 Minimum speed/maximum speed: Can be calibrated from 5 to 108%.

.3 Overload: Adjustable for any percentage of rated current up to 110% to protect motor from excess current at low speeds.

.4 Individual selectable resettable fault control: Automatic functioning of the fault counter reset can be allowed or denied for ground fault, over voltage, under voltage, over current, phase loss, overload, over temperature, external fault, and motor open fault.

.5 Auto rest time: Calibration available from 0 to 300 seconds to prevent too short a reset time from fault occurrence.

.6 Stepover frequency (2 ranges): Adjustable from 0 to 100% speed to allow for critical frequency avoidance.

.6 Additional Features (in addition to start/stop and variable speed):

.1 0-10 VDC follower capacity

.2 Current limit protection

.3 Independently adjustable acceleration/deceleration

.4 Automatic restart

.5 Over/under voltage protection

.6 Over temperature and ground fault protection

.7 Minimum 650 V rating

.8 96% efficiency

.9 Input door-interlocked disconnect switch.

.7 Quality Assurance:

.1 To improve quality and eliminate premature failures, all drives shall be pre-tested and cycled with a motor at an elevated ambient temperature.

1.4 ISOLATION TRANSFORMER

.1 Purpose built drive isolation transformer, sized to match drive capacity.

.2 Housed in NEMA Type 3R enclosure mounted adjacent to drive.

.3 Transformer windings to be copper.

.4 Transformers to incorporate vibration isolation pads in their construction located between the transformer core and coil assembly and the transformer case.

.5 Transformers to incorporate an electrostatic shield for the attenuation of voltage spikes, line noise, and transients.

1.5 STANDARD OF ACCEPTANCE

.1 Acceptable manufacturer: Danfoss, ABB, Yaskawa.

Part 2 EXECUTION

2.1 GENERAL

.1 Review shop drawings for the equipment to be connected to the variable frequency drive and confirm compatibility of the equipment.

.2 Coordinate installation requirements with Division 25.

2.2 INSTALLATION

.1 Install in accordance with manufacturer's requirements.

.2 Install drives on strut or other suitable brackets on wall or free-standing in a location that minimizes the length of load side wiring for the equipment. Review with Departmental Representative prior to installation.

.3 Connect all control wiring and configure to achieve requirements of controls sequence of operation. Controls wiring shall be separated from power wiring by at least 600mm and shall be shielded to prevent problems resulting from interference.

.4 The manufacturer's representative shall program, start-up, commission and test the drives and shall confirm that settings have been optimized for the application.

.5 Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.

2.3 TRAINING

.1 Provide minimum of 8 hours training for each type of variable frequency drive supplied under this contract. Training shall be site-specific and be focused on the particular application.

.2 Provide training materials in written and electronic format. Ensure that operating manuals and drawings are available and provided to trainees, and form part of the training materials.

.3 Training shall be focused on the application as well as the operation and maintenance of the drive.

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 Requirements

.1 01 91 31 requirements for Commissioning Plan

.2 01 91 33 requirements for Commissioning Forms

.3 01 91 41 requirements for Commissioning Training

.3 Acronyms & Definitions:

.1 BMM - Building Management Manual.

.2 Cx - Commissioning.

.3 EMCS - Energy Monitoring and Control Systems.

.4 O M - Operation and Maintenance.

.5 IVC – Installation Verification Checklist

.6 FPT – Functional Performance Testing

.7 PI - Product Information.

.8 PV - Performance Verification.

.9 TAB - Testing, Adjusting and Balancing.

.10 Cx Issues Log – Commissioning Issues Log. This document is provided by the Departmental Representative and contains a record of the issues found during commissioning which are to be addressed by the contractor.

1.2 GENERAL

.1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:

.1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.

.2 Ensure appropriate documentation is compiled into the BMM.

.3 Effectively train O M staff.

.2 Assist in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively

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

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

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

1.3 COMMISSIONING OVERVIEW

.1 Section 01 91 31 - Commissioning (Cx) Plan.

.2 For Cx responsibilities refer to Section 01 91 31 - Commissioning (Cx) Plan.

.3 Cx to be a line item in cost breakdown.

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

.5 Cx is conducted in concert with activities performed during all stages of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.

.6 Departmental Representative will issue Interim Acceptance Certificate when:

.1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.

.2 Equipment, components, sub-systems, systems and integrated systems have been commissioned.

.3 Integrated system testing has been successfully completed.

.4 O M training has been completed.

.5 Items identified on the Cx Issues Log have been addressed and corrected.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

.1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.

.2 Bear costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

.1 Before Construction:

.1 Review contract documents, confirm by writing to Departmental Representative.

.1 Adequacy of provisions for Cx.

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

.2 During Construction:

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

.2 Complete and submit required commissioning documentation.

.1 Refer to Section 01 91 31 Commissioning (Cx) Plan

.3 Complete testing requirements identified in this specification as well as the specific specification section relevant to the equipment being tested.

.3 Before start of Functional Performance Testing:

.1 Ensure installation of related components, equipment, subsystems, and systems are complete.

.2 Fully understand Cx requirements and procedures.

.3 Have Cx documentation shelf-ready.

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

.5 Submit complete IVC and start-up documentation to Departmental Representative.

.6 Have Cx schedules up-to-date.

.7 Ensure systems have been cleaned thoroughly.

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

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

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

1.6 CONFLICTS

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

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

1.7 ACTION AND INFORMATIONAL SUBMITTALS

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

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

.1 Preliminary Cx schedule.

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

.3 Provide additional documentation relating to Cx process required by Departmental Representative.

1.8 COMMISSIONING DOCUMENTATION

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Verification Check Lists, Start-up Forms and Functional Performance Testing Checklists requirements and instructions for use.

.2 Provide completed Cx documentation to the Departmental Representative.

1.9 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule

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

.1 Completion of installation verification and start-up reports.
.2 Approval of Cx reports.
.3 Functional performance testing of subsystems, systems and integrated systems.
.4 Repairs, retesting, re-commissioning, re-verification.
.5 Training.

1.10 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings.

.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.

1.11 STARTING AND TESTING

.1 Assume liabilities and costs for inspections. This includes disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

1.12 WITNESSING OF STARTING AND TESTING

.1 Provide 14 days notice prior to commencement of equipment start-up or testing.

.2 Departmental Representative to witness start-up and testing where desired.

1.13 MANUFACTURER'S INVOLVEMENT

.1 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative.

.1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
.2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.2 Integrity of warranties:

.1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.

.2 Verify with manufacturer that testing as specified will not void warranties.

.3 Qualifications of manufacturer's personnel:

.1 Experienced in design, installation and operation of equipment and systems.

.2 Ability to interpret test results accurately.

.3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing, and functional testing.

.2 Conduct start-up and testing in following distinct phases:

.1 Included in delivery and installation:

.1 Verification of conformity to specification, approved shop drawings and completion of IVC report forms.

.2 Visual inspection of quality of installation.

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

.3 Operational testing: document equipment performance.

.4 System FPT: include for repetition of tests after correcting deficiencies.

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

.3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.

.4 Document required testing results on approved IVC and Start-up forms.

.1 Refer to Section 01 91 33 Commissioning Forms

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by the Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

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

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

.3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.

.1 Rejected equipment to be 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 Departmental Representative for approval before commencement of functional performance testing.

.2 Start-up documentation to include:

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

.2 Completed and approved installation verification checklists

.3 Start-up reports,

.4 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 Departmental Representative for approval before implementation.

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

.4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

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

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

1.18 START OF FUNCTIONAL PERFORMANCE TESTING

.1 Notify Departmental Representative 5 days prior to start of functional performance testing

.2 Start functional performance testing 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 FUNCTIONAL PERFORMANCE TESTING

.1 Carry out functional performance testing:

.1 Following procedures illustrated in the approved functional performance testing sheets.

.2 Under actual or accepted simulated operating conditions, over entire operating range, in all modes.

.3 On independent systems and integrated systems.

.2 Departmental Representative will develop functional performance testing forms.

.3 Departmental Representative will complete functional performance testing forms while witnessing testing.

.4 Follow equipment manufacturer's operating instructions.

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

1.21 WITNESSING COMMISSIONING

.1 Departmental Representative will witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

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

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

.3 Provide copies to Departmental Representative within 5 days of test.

1.23 COMMISSIONING CONSTRAINTS

.1 Since access into secure or sensitive areas will be very difficult after occupancy it is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems in these areas before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.24 EXTRAPOLATION OF RESULTS

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

1.25 EXTENT OF VERIFICATION

.1 Central Systems:

.1 Provide manpower and instrumentation to functionally test 100% of the equipment, components, subsystems and integrated systems.

.2 Distributed Equipment:

.1 Provide manpower and instrumentation to verify 100% of the equipment, components, subsystems, systems and integrated systems, unless specified otherwise

.3 Number and location to be at discretion of Departmental Representative.

.4 Conduct tests repeated during functional testing under same conditions as original tests, using same test equipment, instrumentation.

.5 Review and repeat functional testing of systems to correct deficiencies as noted by the Departmental Representative.

.6 Perform additional commissioning until results are acceptable to Departmental Representative.

1.26 REPEAT VERIFICATIONS

.1 Assume costs incurred by Departmental Representative for third and subsequent functional performance testing where:

.1 Verification of reported results fail to receive Departmental Representative's approval.

.2 Repetition of second verification again fails to receive approval.

.3 Departmental Representative deems request for second verification was premature.

1.27 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.

1.28 DEFICIENCIES, FAULTS, DEFECTS

.1 Correct deficiencies found during installation verification, start-up and functional performance testing to satisfaction of Departmental Representative.

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

.3 A Cx Issues Log will be created and maintained by the Departmental Representative throughout the project, identifying issues from installation, start-up, and functional testing of systems and integrated systems.

.4 Correct and respond in writing to the items identified on the Cx Issues Log, clearly identifying how the issue has been resolved. Written responses shall be provided to the Departmental Representative.

1.29 COMPLETION OF COMMISSIONING

.1 Upon completion of functional performance testing, leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities specified in Cx specifications, complete all Cx prior to issuance of Interim Certificate of Completion.

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

1.30 TRAINING

.1 In accordance with Section 01 91 41 - Commissioning (Cx) - Training.

1.31 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.32 OCCUPANCY

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

1.33 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and functional performance testing if:

.1 Accuracy complies with these specifications.

.2 Calibration certificates have been deposited with Departmental Representative.

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

1.34 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances:

.1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.

.2 Instrument accuracy tolerances:

.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

.1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

1.35 OWNER'S PERFORMANCE TESTING

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

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION