



## SPECIFICATION

Project No. R.077058.001

Saskatoon Research Centre Building Automation System  
Agriculture and Agri-Food Canada Research Centre  
Saskatoon, Saskatchewan

Solicitation No.



**DRAWINGS:**

H01	Mechanical - Administration Building - Basement Floor Plan
H02	Mechanical - Administration Building - Fourth Floor Plan
H03	Mechanical - Laboratory Building - Sub-Basement Floor Plan
H04	Mechanical - Header House - Partial Basement Plan
H05	Mechanical - Header House - Partial Second Floor Plan
H06	Mechanical - Laboratory Building Roof Plan
H07	Mechanical - Controls Schematic

**SPECIFICATIONS:**

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**Part 1 General**

**1.1 WORK COVERED BY CONTRACT DOCUMENTS**

- .1 Work of this Contract comprises upgrades to the Building Automation System, located at Agriculture and Agri-Food Canada's (AAFC) Saskatoon Research Centre.
- .2 The work consists of upgrading 8 Supervisory Controllers and one Operator Work Station (OWS) that are obsolete. The existing controllers to operate in parallel to new controllers until new controllers are fully commissioned. The existing controllers are to be de-commissioned and removed upon acceptance of the new controllers by the Departmental Representative. The new controller shall be capable of communication via N2 and BacNet communication protocols.
- .3 New controls shall match the existing Johnson Controls Metasys Controls system in the Facility.
- .4 Contractor is required to develop commissioning and functional testing forms for each controller and submit to Departmental Representative for review and approval.

**1.2 FUTURE WORK**

- .1 Approximately 60% of the Field Level Devices have been replaced and are in good working order. Therefore, replacement of the Field Level Devices is not part of this project. AAFC intends to replace the existing Field Level Devices in the future as and when needed, with new BacNet devices. The new supervisory controllers installed under this project shall be capable of communicating using BacNet protocol with future Field Level Devices.
- .2 Insure that Work avoids encroachment into areas required for future work.

**1.3 WORK SEQUENCE**

- .1 Construct Work in stages to accommodate continued use of premises during construction.
- .2 Refer to Section 23 09 33 - DDC Systems for HVAC for Work sequence and phasing.
- .3 Co-ordinate Progress Schedule.
- .4 Maintain fire access/control.

**1.4 CONTRACTOR USE OF PREMISES**

- .1 Limit use of premises for Work, for storage, for access, to allow:
  - .1 AAFC occupancy.
  - .2 Work by other contractors.
  - .3 Public usage.
- .2 Co-ordinate use of premises under direction of Department Representative.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.

- .5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.
- .6 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

### **1.5 OWNER OCCUPANCY**

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

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

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

### **1.7 EXISTING SERVICES**

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

**1.8 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 2 Products**

**2.1 NOT USED**

- .1 Not used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

**Part 1            General**

**1.1            ACCESS AND EGRESS**

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

**1.2            USE OF SITE AND FACILITIES**

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

**1.3            WORK HOURS**

- .1 The work that would be disruptive to AAFC's day to day operations shall be restricted to off hours. Co-ordinate with and obtain approval from Department Representative.

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

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

**1.5            EXISTING SERVICES**

- .1 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants.
- .2 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

**1.6            SPECIAL REQUIREMENTS**

- .1 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .2 Keep within limits of work and avenues of ingress and egress.

**1.7            BUILDING SMOKING ENVIRONMENT**

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

**Part 2            Products**

- 2.1                NOT USED**  
                    .1        Not Used.

**Part 3            Execution**

- 3.1                NOT USED**  
                    .1        Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                ADMINISTRATIVE**

- .1    Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.
- .2    Prepare agenda for meetings.
- .3    Distribute written notice of each meeting seven days in advance of meeting date to Departmental Representative.
- .4    Provide physical space and make arrangements for meetings.
- .5    Preside at meetings.
- .6    Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7    Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants and, affected parties not in attendance including Departmental Representative.
- .8    Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

**1.2                PRECONSTRUCTION MEETING**

- .1    Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2    Departmental Representative, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3    Establish time and location of meeting and notify parties concerned minimum 7 days before meeting.
- .4    Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
- .5    Agenda to include:
  - .1    Appointment of official representative of participants in the Work.
  - .2    Schedule of Work: in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart.
  - .3    Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .4    Delivery schedule of specified equipment.
  - .5    Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
  - .6    Owner provided products.
  - .7    Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .8    Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
  - .9    Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.

- .10 Monthly progress claims, administrative procedures, photographs, hold backs.
- .11 Appointment of inspection and testing agencies or firms.
- .12 Insurances, transcript of policies.

**1.3 PROGRESS MEETINGS**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **Part 1 General**

### **1.1 DEFINITIONS**

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

### **1.2 REQUIREMENTS**

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

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

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

#### **1.4 PROJECT MILESTONES**

- .1 Project milestones form interim targets for Project Schedule.
  - .1 Interim Certificate (Substantial Completion) within 60 working days of Award of Contract date.

#### **1.5 MASTER PLAN**

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

#### **1.6 PROJECT SCHEDULE**

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:
  - .1 Award.
  - .2 Shop Drawings, Samples.
  - .3 Permits.
  - .4 Mobilization.
  - .5 Off site programming
  - .6 Installation
  - .7 On site programming
  - .8 Testing and Commissioning.

#### **1.7 PROJECT SCHEDULE REPORTING**

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

**1.8 PROJECT MEETINGS**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

**Part 1            General**

**1.1                ADMINISTRATIVE**

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

**1.2                SHOP DRAWINGS AND PRODUCT DATA**

- .1        The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2        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.
- .3        Allow 14 days for Departmental Representative's review of each submission.
- .4        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.
- .5        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.

- .6 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:
    - .1 Subcontractor.
    - .2 Supplier.
    - .3 Manufacturer.
  - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
  - .5 Details of appropriate portions of Work as applicable:
    - .1 Fabrication.
    - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
    - .3 Setting or erection details.
    - .4 Capacities.
    - .5 Performance characteristics.
    - .6 Standards.
    - .7 Operating weight.
    - .8 Wiring diagrams.
    - .9 Single line and schematic diagrams.
    - .10 Relationship to adjacent work.
- .8 After Departmental Representative's review, distribute copies.
- .9 Submit electronic (PDF) copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .10 Submit electronic (PDF) copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .11 Delete information not applicable to the project.
- .12 Supplement standard information to provide details applicable to project.
- .13 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

- .14 The review of shop drawings by Departmental Representative is for the sole purpose of ascertaining conformance with general concept.
  - .1 This 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 sit, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

**1.3 CERTIFICATES AND TRANSCRIPTS**

- .1 Immediately after award of Contract, submit Workers' Compensation Board status.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
  - .2 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
- .2 Canadian Standards Association (CSA International)
  - .1 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .2 CSA-0121-M1978(R2003), Douglas Fir Plywood.
  - .3 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.
  - .4 CAN/CSA-Z321-96(R2001), Signs and Symbols for the Occupational Environment.
- .3 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as of: May 14, 2004.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 INSTALLATION AND REMOVAL**

- .1 Coordinate, confirm and obtain approval for all facilities with Departmental Representative prior to installation.
- .2 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.
- .3 Identify areas which have to be gravelled to prevent tracking of mud.
- .4 Indicate use of supplemental or other staging area.
- .5 Provide construction facilities in order to execute work expeditiously.
- .6 Remove from site all such work after use.

**1.4 SCAFFOLDING**

- .1 Scaffolding in accordance with CAN/CSA-S269.2.
- .2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms, and temporary stairs as required.

**1.5 SITE STORAGE/LOADING**

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

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

**1.6 CONSTRUCTION PARKING**

- .1 Parking will be permitted on site provided it does not disrupt performance of Work.
- .2 Provide and maintain adequate access to project site.
- .3 Costs relating to parking are the responsibility of the contractor.

**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.

**1.8 SANITARY FACILITIES**

- .1 Use sanitary facilities designated by Department Representative.
- .2 Keep area and premises in sanitary condition.

**1.9 CLEAN-UP**

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.
- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
  - .2 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
- .2 Canadian Standards Association (CSA International)
  - .1 CSA-O121-M1978(R2003), Douglas Fir Plywood.

**1.2 INSTALLATION AND REMOVAL**

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

**1.3 GUARD RAILS AND BARRICADES**

- .1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs.
- .2 Provide as required by governing authorities and as indicated.

**1.4 WEATHER ENCLOSURES**

- .1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.
- .3 Design enclosures to withstand wind pressure and snow loading.

**1.5 DUST TIGHT SCREENS**

- .1 Provide dust tight screens or insulated partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.
- .2 Maintain and relocate protection until such work is complete.

**1.6 ACCESS TO SITE**

- .1 Shall be coordinated with the Departmental Representative.

**1.7 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY**

- .1 Protect surrounding private and public property from damage during performance of Work.
- .2 Be responsible for damage incurred.

**1.8 PROTECTION OF BUILDING FINISHES**

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

- .2 Provide necessary screens, covers, and hoardings.
- .3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.
- .4 Be responsible for damage incurred due to lack of or improper protection.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

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

**1.2                QUALITY**

- .1        Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .2        Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .3        Should disputes arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.
- .4        Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .5        Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

**1.3                AVAILABILITY**

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

**1.4                STORAGE, HANDLING AND PROTECTION**

- .1        Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2        Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3        Store products subject to damage from weather in weatherproof enclosures.
- .4        Store cementitious products clear of earth or concrete floors, and away from walls.
- .5        Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

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

## **1.5 TRANSPORTATION**

- .1 Pay costs of transportation of products required in performance of Work.
- .2 Transportation cost of products supplied by Departmental Representative will be paid for by Departmental Representative. Unload, handle and store such products.

## **1.6 MANUFACTURER'S INSTRUCTIONS**

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

## **1.7 QUALITY OF WORK**

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

## **1.8 CO-ORDINATION**

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

## **1.9 CONCEALMENT**

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

## **1.10 REMEDIAL WORK**

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

## **1.11 LOCATION OF FIXTURES**

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

## **1.12 FASTENINGS**

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

## **1.13 FASTENINGS - EQUIPMENT**

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

**1.14 PROTECTION OF WORK IN PROGRESS**

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

**1.15 EXISTING UTILITIES**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                PROJECT CLEANLINESS**

- .1      Maintain Work in tidy condition, free from accumulation of waste products and debris.
- .2      Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .3      Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .4      Provide on-site containers for collection of waste materials and debris.
- .5      Dispose of waste materials and debris off site.
- .6      Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .7      Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .8      Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .9      Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .10     Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

**1.2                FINAL CLEANING**

- .1      When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2      Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3      Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4      Remove waste products and debris other than that caused by Departmental Representative or other Contractors.
- .5      Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .6      Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7      Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .8      Clean lighting reflectors, lenses, and other lighting surfaces.
- .9      Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .10     Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .11     Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

**Part 2            Products**

**2.1                NOT USED**

.1                Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1                Not Used.

**END OF SECTION**

## **Part 1           General**

### **1.1               WASTE MANAGEMENT GOALS**

- .1     Prior to start of Work conduct meeting with Departmental Representative to review and discuss PWGSC's waste management goal and Contractor's proposed Waste Reduction Workplan for Construction, Renovation and /or Demolition (CRD) waste to be project generated.
- .2     PWGSC's waste management goal: to divert a minimum 75 percent of total Project Waste from landfill sites. Prior to project completion provide Departmental Representative documentation certifying that waste management, recycling, reuse of recyclable and reusable materials have been extensively practiced.
- .3     Target percentage goals are achievable for waste diversion. Contractor to review and confirm Departmental Representative's Waste Audit acceptable values.
- .4     Minimize amount of non-hazardous solid waste generated by project and accomplish maximum source reduction, reuse and recycling of solid waste produced by CRD activities.
- .5     Protect environment and prevent environmental pollution damage.

### **1.2               REFERENCES**

- .1     Definitions:
  - .1     Approved/Authorized recycling facility: waste recycler approved by applicable provincial authority or other users of material for recycling approved by the Departmental Representative.
  - .2     Class III: non-hazardous waste - construction renovation and demolition waste.
  - .3     Construction, Renovation and/or Demolition (CRD) Waste: Class III solid, non-hazardous waste materials generated during construction, demolition, and/or renovation activities
  - .4     Cost/Revenue Analysis Workplan (CRAW): based on information from Waste Reduction Workplan, and intended as financial tracking tool for determining economic status of waste management practices (Schedule E).
  - .5     Inert Fill: inert waste - exclusively asphalt and concrete.
  - .6     Waste Source Separation Program (WSSP): implementation and co-ordination of ongoing activities to ensure designated waste materials will be sorted into pre-defined categories and sent for recycling and reuse, maximizing diversion and potential to reduce disposal costs.
  - .7     Recyclable: ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse.
  - .8     Recycle: process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.
  - .9     Recycling: process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

- .10 Reuse: repeated use of product in same form but not necessarily for same purpose. Reuse includes:
    - .1 Salvaging reusable materials from re-modelling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.
    - .2 Returning reusable items including pallets or unused products to vendors.
  - .11 Salvage: removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.
  - .12 Separate Condition: refers to waste sorted into individual types.
  - .13 Source Separation: act of keeping different types of waste materials separate beginning from the point they became waste.
  - .14 Waste Audit (WA): detailed inventory of estimated quantities of waste materials that will be generated during construction, demolition, deconstruction and/or renovation. Involves quantifying by volume/weight amounts of materials and wastes that will be reused, recycled or landfilled. Refer to Schedule A.
  - .15 Waste Diversion Report: detailed report of final results, quantifying cumulative weights and percentages of waste materials reused, recycled and landfilled over course of project. Measures success against Waste Reduction Workplan (WRW) goals and identifies lessons learned.
  - .16 Waste Management Co-ordinator (WMC) : contractor representative responsible for supervising waste management activities as well as co-ordinating required submittal and reporting requirements.
  - .17 Waste Reduction Workplan (WRW): written report which addresses opportunities for reduction, reuse, or recycling of materials generated by project. Specifies diversion goals, implementation and reporting procedures, anticipated results and responsibilities. Waste Reduction Workplan (Schedule B) information acquired from Waste Audit.
- .2 Reference Standards:
- .1 Canada Green Building Council (CaGBC)
    - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).
    - .2 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
    - .3 LEED Canada 2009 for Design and Construction-2010, LEED Canada 2009 for Design and Construction Leadership in Energy and Environmental Design Green Building Rating System Reference Guide.
    - .4 LEED Canada for Existing Buildings, Operations and Maintenance-2009, LEED Canada 2009 Leadership In Energy and Environmental Design Green Building Rating System Reference Guide.
    - .5 Canadian Construction Association (CCA)

- .1 CCA 81-2001: A Best Practices Guide to Solid Waste Reduction.
- .6 Public Works and Government Services Canada (PWGSC)
  - .1 2002 National Construction, Renovation and Demolition Non-Hazardous Solid Waste Management Protocol.
  - .2 CRD Waste Management Market Research Report (available from PWGSC's Environmental Services).
  - .3 Sustainable Development Strategy 2007-2009: Target 2.1 Environmentally Sustainable Use of Natural Resources.
    - .1 Real Property projects over \$1 million and in communities where industrial recycling is supported, implementation of CRD waste management practices will be completed, with waste materials being reused or recycled.
    - .2 Contractually ensure resources used in construction or maintenance are consumed and recovered in a sustainable manner.

### **1.3 DOCUMENTS**

- .1 Post and maintain in visible and accessible area at job site, one copy of following documents:
  - .1 Waste Audit (Schedule A).
  - .2 Waste Reduction Workplan (Schedule B).
  - .3 Waste Source Separation Program.

### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare and submit following prior to project start-up:
  - .1 1 electronic copy of completed Waste Audit (WA): Schedule A.
  - .2 1 electronic copy of completed Waste Reduction Workplan (WRW): Schedule B.
  - .3 1 electronic copy of Waste Source Separation Program (WSSP).
- .3 Prepare and submit on monthly basis, throughout project or at intervals agreed to by Departmental Representative the following:
  - .1 Receipts, scale tickets, waybills, and/or waste disposal receipts that show quantities and types of materials reused, recycled, or disposed of.
  - .2 Written monthly summary report detailing cumulative amounts of waste materials reused, recycled and landfilled, and brief status of ongoing waste management activities.
- .4 Submit prior to final payment the following:

- .1 Waste Diversion Report, indicating final quantities by material types salvaged for reuse, recycling or disposal in landfill and recycling centres, re-use depots, landfills and other waste processors that received waste materials (See Schedule C).
- .2 Provide receipts, scale tickets, waybills, waste disposal receipts that confirm quantities and types of materials reused, recycled or disposed of and destination.

### **1.5 WASTE AUDIT (WA)**

- .1 Contractor shall prepare WA prior to project start-up.
- .2 WA provides detailed inventory, estimated quantities and types of waste materials that will be generated as well as their potential to be reused and/or recycled and project's waste diversion goals and objectives.
- .3 Post on-site WA where contractor and sub-contractors are able to review content.

### **1.6 WASTE REDUCTION WORKPLAN (WRW)**

- .1 Prepare and submit WRW (Schedule B) at least 10 days prior to project start-up.
- .2 WRW identifies strategies to optimize diversion through reduction, reuse, and recycling of materials and comply with applicable regulations, based on information acquired from WA.
- .3 WRW should include but not limited to:
  - .1 Applicable regulations.
  - .2 Specific goals for waste reduction, identify existing barriers and develop strategies to overcome them.
  - .3 Destination of materials identified.
  - .4 Deconstruction/disassembly techniques and schedules.
  - .5 Methods to collect, separate, and reduce generated wastes.
  - .6 Location of waste bins on-site.
  - .7 Security of on-site stock piles and waste bins.
  - .8 Protection of personnel, sub-contractors.
  - .9 Clear labelling of storage areas.
  - .10 Training plan for contractor and sub-contractors.
  - .11 Details on materials handling and removal procedures.
  - .12 Recycler and reclaimer requirements.
  - .13 Quantities of materials to be salvaged for reuse or recycled and materials sent to landfill.
  - .14 Requirements for monitoring on-site wastes management activities.
- .4 Structure WRW to prioritize actions and follow 3R's hierarchy, with Reduction as first priority, followed by Reuse, then Recycle.
- .5 Post WRW or summary where workers at site are able to review content.

## **1.7 WASTE SOURCE SEPARATION PROGRAM (WSSP)**

- .1 As part of Waste Reduction Workplan, prepare WSSP prior to project start-up.
- .2 WSSP will detail methodology and planned on-site activities for separation of reusable and recyclable materials from waste intended for landfill.
- .3 Provide list and drawings of locations that will be made available for sorting, collection, handling and storage of anticipated quantities of reusable and recyclable materials.
- .4 Provide sufficient on-site facilities and containers for collection, handling, and storage of anticipated quantities of reusable and recyclable materials.
- .5 Locate containers to facilitate deposit of materials without hindering daily operations.
- .6 Provide training for workers in handling and separation of materials for reuse and/or recycling.
- .7 Locate separated materials in areas which minimizes material damage.
- .8 Clearly and securely label containers to identify types/conditions of materials accepted and assist workers in separating materials accordingly.
- .9 Monitor on-site waste management activities by conducting periodic site inspections to verify: state of signage, contamination levels, bin locations and condition, personnel participation, use of waste tracking forms and collection of waybills, receipts and invoices.
- .10 On-site sale of salvaged materials is not permitted unless authorized in writing by Departmental Representative and provided that site safety regulations and security requirements are adhered to.

## **1.8 USE OF SITE AND FACILITIES**

- .1 Execute Work with minimal interference and disturbance to normal use of premises.
- .2 Maintain security measures established by facility provide temporary security measures approved by Departmental Representative.

## **1.9 WASTE PROCESSING SITES**

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

## **1.10 STORAGE, HANDLING AND PROTECTION**

- .1 Store, materials to be reused, recycled and salvaged in locations as directed by Departmental Representative.
- .2 Unless specified otherwise, materials for removal become Contractor's property.
- .3 Protect, stockpile, store and catalogue salvaged items.
- .4 Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to licensed disposal facility.

- .5 Protect structural components not removed and salvaged materials from movement or damage.
- .6 Support affected structures. If safety of building is endangered, cease operations and immediately notify Departmental Representative.
- .7 Protect surface drainage, mechanical and electrical from damage and blockage.
- .8 Provide on-site facilities and containers for collection and storage of reusable and recyclable materials.
- .9 Separate and store materials produced during project in designated areas.
- .10 Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with requirements for acceptance by designated processing facilities.
  - .1 On-site source separation is recommended.
  - .2 Remove co-mingled materials to off site processing facility for separation.
  - .3 Obtain waybills, receipts and/or scale tickets for separated materials removed from site.
  - .4 Materials reused on-site are considered to be diverted from landfill and as such are to be included in all reporting.

#### **1.11 DISPOSAL OF WASTES**

- .1 Do not bury rubbish or waste materials.
- .2 Do not dispose of waste, volatile materials, mineral spirits, oil, paint thinner into waterways, storm, or sanitary sewers.
- .3 Keep records of construction waste including:
  - .1 Number and size of bins.
  - .2 Waste type of each bin.
  - .3 Total tonnage generated.
  - .4 Tonnage reused or recycled.
  - .5 Reused or recycled waste destination.
- .4 Remove materials on-site as Work progresses.
- .5 Prepare project summary to verify destination and quantities on a material-by-material basis as identified in the waste audit.

#### **1.12 SCHEDULING**

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

#### **Part 2 Products**

##### **2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 APPLICATION**

- .1 Do Work in compliance with WRW and WSSP.
- .2 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

**3.2 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**3.3 WASTE DIVERSION REPORT**

- .1 At completion of Project, prepare written Waste Diversion Report indicating quantities of materials reused, recycled or disposed of as well as the following:
  - .1 Identify final diversion results and measure success against goals from Waste Reduction Workplan.
  - .2 Compare final quantities/percentages diverted with initial projections in Waste Audit and Waste Reduction Workplan and explain variances.
    - .1 Supporting documentation.
    - .2 Waybills and tracking forms.
    - .3 Description of issues, resolutions and lessons learned.

**3.4 WASTE AUDIT (WA)**

- .1 Schedule A - Waste Audit (WA)

(1) Material Category	(2) Material Quantity Unit	(3) Estimated Waste %	(4) Total Quantity of Waste (unit)	(5) Generation Point	(6) % Recycled	(7) % Reused
Wood and Plastics Material Description						
Off-cuts						
Warped Pallet Forms						
Plastic Packaging						
Cardboard Packaging						
Other						

(1) Material Category	(2) Material Quantity Unit	(3) Estimated Waste %	(4) Total Quantity of Waste (unit)	(5) Generation Point	(6) % Recycled	(7) % Reused
Doors and Windows Material Description						
Painted Frames						
Glass						
Wood						
Metal						
Other						

**3.5 WASTE REDUCTION WORKPLAN (WRW)**

.1 Schedule B

(1) Material Category	(2) Person(s) Responsible	(3) Total Quantity of Waste (unit)	(4) Reused Amount (units) Projected	Actual	(5) Recycled Amount (unit) Projected	Actual	(6) Material(s) Destination
Wood and Plastics Material Description							
Chutes							
Warped Pallet Forms							
Plastic Packaging							
Card-board Packaging							
Other							
Doors and Windows Material Description							
Painted Frames							
Glass							
Wood							
Metal							
Other							

**3.6 CANADIAN GOVERNMENTAL DEPARTMENTS CHIEF RESPONSIBILITY FOR THE ENVIRONMENT**

.1 Schedule G - Government Chief Responsibility for the Environment:

Province	Address	General Inquires	Fax
Saskatchewan	Saskatchewan Environment and Resource Management 3211 Albert Street Regina SK S4S 5W6	306-787-2700	306-787-3941

**END OF SECTION**

**Part 1            General**

**1.1                ADMINISTRATIVE REQUIREMENTS**

- .1    Acceptance of Work Procedures:
  - .1    Contractor's Inspection: Contractor: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
    - .1    Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
    - .2    Request Departmental Representative's inspection.
  - .2    Departmental Representative's Inspection:
    - .1    Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.
    - .2    Contractor to correct Work as directed.
  - .3    Completion Tasks: submit written certificates that tasks have been performed as follows:
    - .1    Work: completed and inspected for compliance with Contract Documents.
    - .2    Defects: corrected and deficiencies completed.
    - .3    Equipment and systems: tested, adjusted and fully operational.
    - .4    Certificates required by Utility companies: submitted.
    - .5    Operation of systems: demonstrated to Departmental Representative's personnel.
    - .6    Work: complete and ready for final inspection.
  - .4    Final Inspection:
    - .1    When completion tasks are done, request final inspection of Work by Departmental Representative.
    - .2    When Work incomplete according to Departmental Representative, complete outstanding items and request re-inspection.
  - .5    Declaration of Substantial Performance: when Departmental Representative considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

**1.2                FINAL CLEANING**

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

**Part 2            Products**

**2.1                NOT USED**

- .1    Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.2                FORMAT**

- .1 Organize data as instructional manual.
- .2 Manual shall be submitted in electronic portable document format (PDF) and 3 hard copy binders.
- .3 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .4 When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.
- .5 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .6 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .7 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .8 Text: manufacturer's printed data, or typewritten data.
- .9 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

**1.3                CONTENTS - PROJECT RECORD DOCUMENTS**

- .1 Table of Contents for Each Volume: provide title of project;
  - .1 Date of submission; names.
  - .2 Addresses, and telephone numbers of Departmental Representative and Contractor with name of responsible parties.
  - .3 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
  - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

#### **1.4 AS -BUILT DOCUMENTS AND SAMPLES**

- .1 Maintain, in addition to requirements in General Conditions, at site Departmental Representative one record copy of:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Change Orders and other modifications to Contract.
  - .5 Reviewed shop drawings, product data, and samples.
  - .6 Field test records.
  - .7 Inspection certificates.
  - .8 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection.

#### **1.5 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS**

- .1 Record information on set of opaque drawings, and in copy of Project Manual.
- .2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
  - .1 Measured depths of elements of foundation in relation to finish first floor datum.
  - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
  - .4 Field changes of dimension and detail.
  - .5 Changes made by change orders.
  - .6 Details not on original Contract Drawings.
  - .7 References to related shop drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
  - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
  - .2 Changes made by Addenda and change orders.

- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, and field test records, required by individual specifications sections.
- .7 Provide digital photos, if requested, for site records.

## **1.6 EQUIPMENT AND SYSTEMS**

- .1 For each item of equipment and each system include description of unit or system, and component parts.
  - .1 Give function, normal operation characteristics and limiting conditions.
  - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
  - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
  - .2 Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Additional requirements: as specified in individual specification sections.

## **1.7 MATERIALS AND FINISHES**

- .1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

- .3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional requirements: as specified in individual specifications sections.

## **1.8 MAINTENANCE MATERIALS**

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

## **1.9 DELIVERY, STORAGE AND HANDLING**

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and for review by Departmental Representative.

**1.10 WARRANTIES**

- .1 Separate each warranty with index tab sheets keyed to Table of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.
- .4 Except for items put into use with Departmental Representative's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.
- .5 Verify that documents are in proper form, contain full information, and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties until time specified for submittal.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                DESCRIPTION**

- .1     Demonstrate scheduled operation and maintenance of equipment and systems to Departmental Representative's personnel two weeks prior to date of final inspection.
- .2     Contractor shall submit the course contents to Departmental Representative's review minimum of 2 weeks prior to the training session. The contractor shall incorporate all comments from the Departmental Representative and submit the finalized course content at least two weeks prior to first training session.
- .3     Departmental Representative will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times.

**1.2                QUALITY CONTROL**

- .1     When specified in individual Sections require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Departmental Representative's personnel, and provide written report that demonstration and instructions have been completed.

**1.3                SUBMITTALS**

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

**1.4                CONDITIONS FOR DEMONSTRATIONS**

- .1     Equipment has been inspected and put into operation.
- .2     Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

**1.5                PREPARATION**

- .1     Verify that conditions for demonstration and instructions comply with requirements.
- .2     Verify that designated personnel are present.

**1.6                DEMONSTRATION AND INSTRUCTIONS**

- .1     Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.
- .2     Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3     Review contents of manual in detail to explain aspects of operation and maintenance.
- .4     Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

**1.7 TIME ALLOCATED FOR INSTRUCTIONS**

- .1 For each training session, allow full 8 hour day for instruction and training.
- .2 Provide minimum of one training session at the completion of each phase.
- .3 The date and time of the training sessions shall be co-ordinated with the Departmental Representative.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **Part 1 General**

### **1.1 SUMMARY**

- .1 Acronyms:
  - .1 Cx - Commissioning.
  - .2 O&M - Operation and Maintenance.
  - .3 PI - Product Information.
  - .4 PV - Performance Verification.

### **1.2 COMMISSIONING PLAN**

- .1 Refer to Section 01 91 31.

### **1.3 GENERAL**

- .1 CX is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
  - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
  - .2 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
  - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
  - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Departmental Representative will issue Substantial Performance Certification when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by the Department Representative.
  - .2 Equipment, components, systems and integrated systems have been fully commissioned and functional as per design intent within the context of the Owner Project Requirement.
  - .3 Final O&M and training manual receive, review and approve by Departmental Representative for suitability.
  - .4 Completion of training sessions to all Operational and Maintenance staff.

### **1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS**

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.

- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

## **1.5 PRE-CX REVIEW**

- .1 Before Construction:
  - .1 Review contract documents, confirm by writing to Departmental Representative.
    - .1 Adequacy of provisions for Cx.
    - .2 Aspects of design and installation pertinent to success of Cx.
  - .2 During Construction:
    - .1 Co-ordinate provision, location and installation of provisions for Cx.
  - .3 Before start of Cx:
    - .1 Have completed Cx Plan up-to-date.
    - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
    - .3 Fully understand Cx requirements and procedures.
    - .4 Have Cx documentation shelf-ready.
    - .5 Understand completely design criteria and intent and special features.
    - .6 Submit complete start-up documentation to Departmental Representative.
    - .7 Have Cx schedules up-to-date.
    - .8 Ensure systems have been cleaned thoroughly.
    - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
    - .10 Ensure "As-Built" system schematics are available.
  - .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

## **1.6 SUBMITTALS**

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

## **1.7 COMMISSIONING DOCUMENTATION**

- .1 Departmental Representative to review and approve Cx documentation.
- .2 Provide completed and approved Cx documentation to Departmental Representative.

## **1.8 STARTING AND TESTING**

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

## **1.9 WITNESSING OF STARTING AND TESTING**

- .1 Provide 14 days notice prior to commencement.
- .2 Departmental Representative to witness of start-up and testing.

## **1.10 MANUFACTURER'S INVOLVEMENT**

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

## **1.11 PROCEDURES**

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

### **1.12 START-UP DOCUMENTATION**

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

### **1.13 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.

### **1.14 TEST RESULTS**

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

### **1.15 START OF COMMISSIONING**

- .1 Start Cx after elements of the facility affecting start-up and performance verification of systems have been completed.

### **1.16 INSTRUMENTS / EQUIPMENT**

- .1 Provide the following equipment as required:
  - .1 2-way radios.
  - .2 Ladders.
  - .3 Equipment as required to complete work.

### **1.17 COMMISSIONING PERFORMANCE VERIFICATION**

- .1 Carry out Cx:
  - .1 Under accepted simulated operating conditions, over entire operating range, in all modes.
  - .2 On independent systems and interacting systems.

- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

#### **1.18 WITNESSING COMMISSIONING**

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

#### **1.19 AUTHORITIES HAVING JURISDICTION**

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

#### **1.20 REPEAT VERIFICATIONS**

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

#### **1.21 DEFICIENCIES, FAULTS, DEFECTS**

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

#### **1.22 COMPLETION OF COMMISSIONING**

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

#### **1.23 ACTIVITIES UPON COMPLETION OF COMMISSIONING**

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

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

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

**1.25 OCCUPANCY**

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

**1.26 INSTALLED INSTRUMENTATION**

- .1 Use instruments installed under Contract for TAB and PV if:
  - .1 Accuracy complies with these specifications.
  - .2 Calibration certificates have been deposited with Departmental Representative.

**1.27 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.

**1.28 DEPARTMENTAL REPRESENTATIVE'S PERFORMANCE TESTING**

- .1 Performance testing of equipment or system 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**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

**1.2 COMMISSIONING TEAM**

.1 The commissioning team is as follows:

OWNER:	AAFC	Ron Rieger
PROJECT MANAGER:	PWGSC	Paul Adekogbe
PRIME CONSULTANT:	KGS Group	Prasan Silva, P.Eng.
COMMISSIONING AUTHORITY (CxA):	KGS Group	Prasan Silva, P.Eng.
CONTRACTOR:		

**1.3 REFERENCES**

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

**1.4 COMMISSIONING FORMS**

- .1 The contractor shall assist the CxA in preparing the following forms during construction:
  - .1 Start up check lists
  - .2 Static verification forms
  - .3 Functional performance test forms

**1.5 GENERAL**

- .1 Provide a fully functional building automation system:

- .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
- .2 Facility user and O M personnel have been fully trained in aspects of installed systems.
- .3 Optimized life cycle costs.
- .4 Complete documentation relating to installed equipment and systems.
- .2 Term "Cx" in this section means "Commissioning".
- .3 Use this Cx Plan as master planning document for Cx:
  - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
  - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
  - .3 Sets out deliverables relating to O M, process and administration of Cx.
  - .4 Describes process of verification of how built works meet design 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 TAB - Testing, Adjusting and Balancing.
  - .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
  - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
  - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

## **1.6 DEVELOPMENT OF 100% CX PLAN**

- .1 Cx Plan to be 95% completed before added into Project Specifications.
- .2 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:

- .1 Approved shop drawings and product data.
- .2 Approved changes to contract.
- .3 Contractor's project schedule.
- .4 Cx schedule.
- .5 Contractor's, sub-contractor's, suppliers' requirements.
- .6 Project construction team's and Cx team's requirements.
- .3 Submit completed Cx Plan to Departmental Representative and obtain written approval.

### **1.7 REFINEMENT OF CX PLAN**

- .1 During construction phase, revise, refine and update Cx Plan to include:
  - .1 Changes resulting from Client program modifications.
  - .2 Approved design and construction changes.
- .2 Revise, refine and update every 6 weeks during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

### **1.8 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM**

- .1 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:
  - .1 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.
    - .4 Monitoring of Cx activities, training, development of Cx documentation.
    - .5 Work closely with members of Cx Team.
- .3 Departmental Representative is responsible for:
  - .1 Organizing Cx.
  - .2 Monitoring operations Cx activities.
  - .3 Witnessing, certifying accuracy of reported results.
  - .4 Witnessing and certifying TAB and other tests.
  - .5 Developing BMM.

- .6 Ensuring implementation of final Cx Plan.
- .7 Performing verification of performance of installed systems and equipment.
- .8 Implementation of Training Plan.
- .4 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
  - .1 Testing.
  - .2 TAB.
  - .3 Performance of Cx activities.
  - .4 Delivery of training and Cx documentation.
  - .5 Assigning one person as point of contact with Consultant and PWGSC. Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx agent implements specified Cx activities including:
  - .1 Demonstrations.
  - .2 Training.
  - .3 Testing.
  - .4 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
  - .1 Receiving facility.
  - .2 Day-To-Day operation and maintenance of facility.

## **1.9 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 Cx for review and approval.

#### **1.10 EXTENT OF CX**

- .1 Building automation system and associated equipment:
  - .1 ADX Server (x1).
  - .2 Network Automation Engines (x8).

#### **1.11 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.

#### **1.12 DELIVERABLES RELATING TO THE CX PROCESS**

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

- .1 Cx as used in this section includes:
  - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
  - .2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
  - .1 Cx Specifications.
  - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
  - .3 Completed installation checklists (ICL).
  - .4 Completed product information (PI) report forms.
  - .5 Completed performance verification (PV) report forms.
  - .6 Results of Performance Verification Tests and Inspections.
  - .7 Description of Cx activities and documentation.
  - .8 Description of Cx of integrated systems and documentation.
  - .9 Training Plans.
  - .10 Cx Reports.
  - .11 Prescribed activities during warranty period.

### **1.13 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION**

- .1 Items listed in this Cx Plan include the following:
  - .1 Pre-Start-Up inspections: by Departmental Representative prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
  - .2 Departmental Representative to use approved check lists.
  - .3 Include completed documentation with Cx report.
- .2 Pre-Cx activities - MECHANICAL:
  - .1 EMCS:
    - .1 EMCS trending to be available as supporting documentation for performance verification.
    - .2 Perform point-by-point testing in parallel with start-up.
    - .3 Carry out point-by-point verification.
    - .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
    - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
    - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".

#### **1.14 START-UP**

- .1 Start-up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
  - .1 ADX Sever and Network Automation Engines.
- .3 Performance Verification (PV):
  - .1 Approved Cx Agent to perform.
    - .1 Repeat when necessary until results are acceptable to Departmental Representative.
    - .2 Use procedures modified generic procedures to suit project requirements.
    - .3 Departmental Representative to witness and certify reported results using approved PI and PV forms.

#### **1.15 CX ACTIVITIES AND RELATED DOCUMENTATION**

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

#### **1.16 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION**

- .1 Cx to be performed by specified Cx specialist, using procedures developed by Departmental Representative and approved by Departmental Representative.
- .2 Tests to be witnessed by Departmental Representative and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Departmental Representative and submitted to Departmental Representative for review.
- .4 Departmental Representative reserves right to verify percentage of reported results.
- .5 Integrated systems to include:
  - .1 The ADX Server, Network Automation Engines, and associated connected devices.

#### **1.17 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.

### **1.18 CX REPORTS**

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

### **1.19 ACTIVITIES DURING WARRANTY PERIOD**

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

### **1.20 TESTS TO BE PERFORMED BY OWNER/USER**

- .1 None is anticipated on this project.

## **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                SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Shop drawings to show:
  - .1        Mounting arrangements.
  - .2        Operating and maintenance clearances.
- .3        Shop drawings and product data accompanied by:
  - .1        Detailed drawings of bases, supports, and anchor bolts.
  - .2        Acoustical sound power data, where applicable.
  - .3        Points of operation on performance curves.
  - .4        Manufacturer to certify current model production.
  - .5        Certification of compliance to applicable codes.
- .4        In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .5        Closeout Submittals:
  - .1        Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2        Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .3        Operation data to include:
    - .1        Control schematics for systems including environmental controls.
    - .2        Description of systems and their controls.
    - .3        Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4        Operation instruction for systems and component.
    - .5        Description of actions to be taken in event of equipment failure.
    - .6        Valves schedule and flow diagram.
    - .7        Colour coding chart.
  - .4        Maintenance data to include:
    - .1        Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
    - .2        Data to include schedules of tasks, frequency, tools required and task time.
  - .5        Performance data to include:
    - .1        Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
    - .2        Equipment performance verification test results.
    - .3        Special performance data as specified.
  - .6        Approvals:
    - .1        Submit 1 copy 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.
- .7 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
  - .1 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.
- .9 As-built drawings:
  - .1 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).
  - .2 Submit to Departmental Representative for approval and make corrections as directed.
  - .3 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .4 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

## **1.2 QUALITY ASSURANCE**

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

## **1.3 MAINTENANCE**

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

## **Part 2 Products (Not Used)**

## **Part 3 Execution**

### **3.1 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.

### **3.2 CLEANING**

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

### **3.3 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### **3.4 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 Heating, Ventilation and Air Conditioning (HVAC) Systems.
  - .2 Controls Systems.
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Departmental Representative may record these demonstrations on video tape for future reference.

### **3.5 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                SUMMARY**

- .1    Section Includes:
  - .1        Materials and requirements for the identification of controls equipment, including the installation and location of identification systems.
- .2    Related Sections:
  - .1        01 33 00 - Submittal Procedures
  - .2        01 74 11 - Cleaning.

**1.2                REFERENCES**

- .1    Canadian General Standards Board (CGSB)
  - .1        CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

**1.3                SUBMITTALS**

- .1    Product Data:
- .2    Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3    Product data to include paint colour chips, other products specified in this section.
- .4    Samples:
  - .1        Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .2        Samples to include nameplates, labels, tags, lists of proposed legends.

**1.4                QUALITY ASSURANCE**

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

**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.

**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.

## 2.2 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.
- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
  - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
  - .2 Equipment in Mechanical Room:
    - .1 Main identifier: size #9.
    - .2 Source and Destination identifiers: size #6.
    - .3 Terminal cabinets, control panels: size #5.
  - .3 Equipment elsewhere: sizes as appropriate.

## 2.3 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

**2.4 EQUIPMENT**

- .1 Identify all equipment with specified tags as indicated on drawings.

**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 TIMING**

- .1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

**3.3 INSTALLATION**

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

**3.4 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
  - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
  - .1 Do not paint, insulate or cover.

**3.5 CLEANING**

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

**END OF SECTION**

## **Part 1           General**

### **1.1               SCOPE OF WORK**

- .1     The scope of work for this project includes the following:
  - .1     Replacement of the existing eight (8) network control modules serving the AAFC Saskatoon Research Centre facility with eight (8) new Network Automation Engines.
  - .2     Replacement of the existing PMI Server (operator work station) with a new ADX Server.
  - .3     Provide new Ethernet connections, including relays and switches, between the ADX server and new Network Automation Engines.
  - .4     Connect new Network Automation Engines to existing Field Level Controllers.
  - .5     Programming and commissioning of the Network Automation Engines and ADX Server. All functions of the existing network control modules and PMI Server shall be re-programmed into the new Network Automation Engines and ADX Server.
  - .6     The existing network control modules and PMI server shall operate in parallel to the new Network Automation Engines and ADX server until the new systems are fully commissioned to the satisfaction of the Departmental Representative. Once the commissioning is completed, changeover to the new system and remove the network control modules and associated control and power wiring.
  - .7     Provide UPS power supply with a 10 minute runtime minimum.
  - .8     Additional work as defined in other sections.

### **1.2               WORK SEQUENCE AND PHASING:**

- .1     The work shall be phases as follows:
  - .1     Phase 1 – Administration Building:
  - .2     Phase 2 – Laboratory Building:
  - .3     Phase 3 – Header House:
  - .4     Phase 4 – Containment Labs

### **1.3               GENERAL**

- .1     All drawings and all sections of the specifications shall apply to and form an integral part of this section.
- .2     Wherever words "shall be capable of" appear in specifications, interpret as meaning that; where feature or performance referred to is being applied, that feature or performance shall be provided. Where feature or performance is not applied now, but will be applied in future, system shall be provided with all necessary central hardware and software required to support that feature or performance, with only addition of field hardware being required at that future time.
- .3     Controls contractor to provide commissioning sheets for all points on field devices as well as head end equipment.

## 1.4 REFERENCES

- .1 All work shall conform to the following Codes and Standards, as applicable:
  - .1 National Fire Protection Association (NFPA) Standards.
  - .2 National Electric Code (NEC) and applicable local Electric Code.
  - .3 Underwriters Laboratories (UL) listing and labels.
  - .4 UL 864 UUKL Smoke Control
  - .5 UL 268 Smoke Detectors.
  - .6 UL 916 Energy Management
  - .7 NFPA 70 - National Electrical Code.
  - .8 NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.
  - .9 NFPA 92A and 92B Smoke Purge/Control Equipment.
  - .10 Factory Mutual (FM).
  - .11 American National Standards Institute (ANSI).
  - .12 National Electric Manufacturer's Association (NEMA).
  - .13 American Society of Mechanical Engineers (ASME).
  - .14 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
  - .15 Air Movement and Control Association (AMCA).
  - .16 Institute of Electrical and Electronic Engineers (IEEE).
  - .17 American Standard Code for Information Interchange (ASCII).
  - .18 Electronics Industries Association (EIA).
  - .19 Occupational Safety and Health Administration (OSHA).
  - .20 American Society for Testing and Materials (ASTM).
  - .21 Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.
  - .22 Americans Disability Act (ADA)
  - .23 ANSI/EIA 909.1-A-1999 (LonWorks)
  - .24 ANSI/ASHRAE Standard 195-2008 (BACnet)
- .2 In the case of conflicts or discrepancies, the more stringent regulation shall apply.
- .3 All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

## 1.5 DEFINITIONS

- .1 Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- .2 Binary: A two-state system where an "ON" condition is represented by one discrete signal level and an "OFF" condition is represented by a second discrete signal level.
- .3 Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor and to be interfaced to the associated work of other related trades.

- .4 BMS Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work.
- .5 Control Sequence: A BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.
- .6 Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- .7 BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.
- .8 Node: A digitally programmable entity existing on the BMS network.
- .9 BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.
- .10 Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- .11 PC: Personal Computer from a recognized major manufacturer
- .12 Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the BMS Contractor's cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.
- .13 Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.
- .14 Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- .15 Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.
- .16 Software: The term "software" and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.
- .17 The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- .18 Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.

- .19 The following abbreviations and acronyms may be used in describing the work of this Division:

ADC	-	Analog to Digital Converter
AHJ	-	Authority Having Jurisdiction
AI	-	Analog Input
AN	-	Application Node
ANSI	-	American National Standards Institute
AO	-	Analog Output
ASCII	-	American Standard Code for Information Interchange
ASHRAE	-	American Society of Heating, Refrigeration and Air Conditioning Engineers
AWG	-	American Wire Gauge
BTL	-	BACnet Testing Laboratories
CPU	-	Central Processing Unit
CRT	-	Cathode Ray Tube
DAC	-	Digital to Analog Converter
DDC	-	Direct Digital Control
DI	-	Digital Input
DO	-	Digital Output
EEPROM	-	Electronically Erasable Programmable Read Only Memory
EMI	-	Electromagnetic Interference
FAS	-	Fire Alarm Detection and Annunciation System
GUI	-	Graphical User Interface
HOA	-	Hand-Off-Auto
ID	-	Identification
IEEE	-	Institute of Electrical and Electronics Engineers
I/O	-	Input/Output
IT	-	Information Technology
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
NC	-	Normally Closed
NIC	-	Not In Contract
NO	-	Normally Open
OWS	-	Operator Workstation
OAT	-	Outdoor Air Temperature
PC	-	Personal Computer
RAM	-	Random Access Memory
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RH	-	Relative Humidity
ROM	-	Read Only Memory
RTD	-	Resistance Temperature Device
SPDT	-	Single Pole Double Throw
SPST	-	Single Pole Single Throw
XVGA	-	Extended Video Graphics Adapter
TBA	-	To Be Advised
TCP/IP	-	Transmission Control Protocol/Internet Protocol

TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
VAC	-	Volts, Alternating Current
VAV	-	Variable Air Volume
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network

## 1.6 WORK INCLUDED

- .1 Labour, material, plant, tools, equipment and services necessary and reasonably incidental to completion of temp. control/instrumentation systems as noted herein and/or on the drawings.
- .2 Control equipment to be product of one manufacturer unless otherwise specified.
- .3 Pre-wired or pre-piped controls on package equipment specified, is not included in this Section.
- .4 Include complete design, supply, installation and commissioning of microprocessor based hardware and software. Components and interconnecting systems to be installed by trained control mechanics, regularly employed by this Section.
- .5 All control wiring shall be run in conduits.

## 1.7 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 019113 - General Commissioning (Cx) Requirements
- .2 Section 230500 – Common Work Results for HVAC
- .3 Section 260500 – Electrical General Requirements
- .4 Section 260520 - Wiring and Box Connectors 0-1000V
- .5 Section 260521 - Wires and Cables 0-1000V
- .6 Section 260529 – Fastenings and Supports
- .7 Section 260531 - Junction and Pull Boxes
- .8 Section 260532 - Outlet Boxes, Conduit Boxes and Fittings
- .9 Section 260534 - Conduits, Conduit Fittings and Conduit Fastenings
- .10 Section 262726 - Wiring Devices
- .11 Section 271005 - Structured Cabling For Building Automation Systems.

## 1.8 WORK SPECIFIED IN OTHER SECTIONS

- .1 The following shall be supplied and installed by Division 26 – Electrical. The controls contractor may use their own electricians or retain a sub-contractor as required:
  - .1 Division 26 – Electrical to supply and install all conduit, conductors and connections from the distribution panels to line side of magnetic starters, thermal overload devices and variable speed drives, and from load side of starters and devices to motors.
  - .2 Division 26 – Electrical to supply and install conduit, conductors and connection for line voltage control devices on single phase equipment such as:
    - .1 Normal and/or emergency power source wiring to Section 230933 systems panels and other devices or groups of devices requiring 120 volt normal and/or emergency power source.

## **1.9 ELECTRICAL WIRING PREFORMED BY SECTION 230933**

- .1 Supply and installation of all wire, electric relays, transformers, connections and other devices required for control circuit wiring for systems as specified in Section 230933, whether line or low voltage, shall be responsibility of Section 230933, except as noted in item 1.4.3.
- .2 Section 230933 shall either use own electricians, retain and pay for services of successful Division 26, or use an electrical sub-trade acceptable to Departmental Representative to supply and install all conduit and wiring for systems as specified in this Section.
- .3 Factory trained servicemen in employ of manufacturer, shall make final wiring connections on all components, mount and electrically connect all controls.
- .4 Electrical wiring shall be installed in conformance with CEC, CSA, ULC, Saskatchewan Building Code, National Building Code of Canada and standards set in Division 26 of this specification.
- .5 Ensure that adequate conduit is installed during initial phases of construction, to accommodate total systems requirements.
- .6 Wire all safety controls in series with both 'Hand' and 'Auto' control positions to ensure that safeties are always enabled.
- .7 Section 230933 shall provide all other conduit and wiring required for Section 230933 systems operation, including tie-ins from Section 230933 supplied relays to motor starting circuits.
- .8 As a minimum, provide separate, dedicated conduit system for each of following.  
Conduit to be minimum 21mm EMT.
  - .1 C.C.M.S. transmission wiring.
  - .2 All other wiring connected to an electronic control system including sensor and control wiring associated with DDC panels, DGP's, Card Access Panels, etc., which are connected to the C.C.M.S. system or are capable of being connected at some future date.
- .9 If approved by system manufacturer, cable up to 30 Volts may be installed in extra-low voltage communication cable tray.
- .10 Refer to Division 26 for conduit and cable identification requirements.

## **1.10 QUALITY ASSURANCE**

- .1 Contractor/Manufacturer Qualifications
  - .1 The Installer shall have an established working relationship with the Control System Manufacturer of not less than three years.
  - .2 The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

## **1.11 SYSTEM PERFORMANCE**

- .1 Performance Standards: The system shall conform to the following:
  - .1 Graphic Display. The system shall display a graphic with 20 dynamic points with all current data within 10 seconds.

- .2 Graphic Refresh. The system shall update a graphic with 20 dynamic points with all current data within 8 seconds.
- .3 Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
- .4 Object Scan. All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 6 seconds.
- .5 Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
- .6 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
- .7 Performance. Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
- .8 Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.
- .9 Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1.
- .10 Stability of Control. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2.

## 1.12 SUBMITTALS

- .1 Product Data and Shop Drawings: Meet requirements of Section 230500 on Shop Drawings, Product Data, and Samples. In addition, Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent. Provide electronic copy in portable document format (PDF) to Departmental Representative. All drawings shall be prepared on a CAD system that produces drawing files compatible with AutoCAD Release 2012 or higher and be provided on magnetic/optical disk or USB Drive and as full-size drawings. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include:
  - .1 A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
  - .2 Manufacturer's description and technical data, such as performance curves, product specification sheets, schematic diagrams, and installation/maintenance instructions for the items listed below and other relevant items not listed below:
    - .1 Network Automation Engines
    - .2 ADX Server.
    - .3 Relays/Switches
    - .4 Control Panels
    - .5 Power Supply

- .6 Batteries
  - .7 Interface Equipment Between CPU and Control Panels
  - .8 Third-Party Software
- 
- .3 Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
  - .4 A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data and show or explain which other screens can be directly accessed.
  - .5 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
  - .6 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.
  - .7 A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface included in the submittal.
- 
- .2 Project Record Documents: Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval in portable document format (PDF) prior to final completion and shall include:
    - .1 Project Record Drawings. These shall be asbuilt versions of the submittal shop drawings. One set of magnetic media including CAD, .DWG, or .DXF drawing files also shall be provided.
    - .2 Testing and Commissioning Reports and Checklists.
    - .3 Operation and Maintenance (O & M) Manual.

### **1.13 WARRANTY**

- .1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Departmental Representative. The contractor shall respond to the Departmental Representative's request for warranty service within 24 hours during normal business hours.
- .2 All work shall have a single warranty date, even when the Departmental Representative has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- .3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Departmental Representative, the Departmental Representative shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.

- .4 Exception: The contractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The contractor shall warrant all installation labor and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of Departmental Representative's acceptance.

#### **1.14 OWNERSHIP OF PROPRIETARY MATERIAL**

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

#### **Part 2 Products**

- .1 BMS Description
  - .1 Any and all components of the BMS that are connected via field bus or IP network, including the network controllers, field controllers, application specific controllers, server and user interface software, system and controller programming tools and software applications shall be designed, engineered, and tested to work together as a complete building management system, and shall be manufactured by the same BMS manufacturer. Systems that use or require network controllers, field controllers, application specific controllers, server and user interface software, programming tools and software from more than one BMS manufacturer shall not be accepted.
  - .2 All points of user interface shall be accessible on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
  - .3 Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as dictated elsewhere in this specification.
  - .4 The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.
  - .5 The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

- .6 Provide a complete, neat and workmanlike installation. Use only manufacturer trained employees who are skilled, experienced, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
  - .7 Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
  - .8 The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
    - .1 Operator information, alarm management and control functions.
    - .2 Enterprise-level information and control access.
    - .3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
    - .4 Diagnostic monitoring and reporting of BMS functions.
    - .5 Offsite monitoring and management access.
    - .6 Energy management
    - .7 Standard applications for terminal HVAC systems.
- .2 General Description
- .1 The building management system (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the internet, or intranets using off the shelf, industry standard technology compatible with other Departmental Representative provided networks.
  - .2 The building management system shall consist of the following:
    - .1 Standalone network automation engine(s)
    - .2 Field equipment controller(s)
    - .3 Input/output module(s)
    - .4 Local display device(s)
    - .5 Portable operator's terminal(s)
    - .6 Distributed user interface(s)
    - .7 Network processing, data storage and communications equipment
    - .8 Other components required for a complete and working BMS
  - .3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
  - .4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
    - .1 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
    - .2 The system shall maintain all settings and overrides through a system reboot.
  - .5 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
  - .6 The system shall comply with (UL) 864 (UUKL) ninth edition smoke control listing including the UL 864 ninth edition standard for control units and accessories for fire alarm systems.

- .1 The system shall comply with the following NFPA codes and standards as applicable:
  - .1 NFPA 70 National Electrical Code
  - .2 NFPA 72 National Fire Alarm Code
  - .3 NFPA 101 Life safety code
  - .4 NFPA 90a Standard for the Installation of Air-Conditioning and Ventilation Systems
  - .5 NFPA 92b Guide for Smoke Management Systems in Malls, Atria, and Large Areas
- .2 The system shall comply with the following international code council (ICC) codes:
  - .1 Building officials and code administrators international (BOMA) model code
  - .2 International conference of building officials (ICBO) model code
  - .3 Southern building code congress international (SBCCI) regulations
- .7 Automation Network
  - .1 The automation network shall be based on a pc industry standard of ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal pc vendor channels.
  - .2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
  - .3 All BMS devices on the automation network shall be capable of operating at a communication speed of 100 mbps, with full peer-to-peer network communication.
  - .4 Network automation engines (NAE) shall reside on the automation network.
  - .5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- .8 Control network
  - .1 Network automation engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
    - .1 BACnet standard MS/TP bus protocol ASHRAE SSPC-135, clause 9
      - .1 the NAE shall be BACnet testing labs (BTL) certified and carry the BTL label.
      - .2 the NAE shall be tested and certified as a BACnet building controller (b-bc).
    - .2 Lonworks enabled devices using the free topology transceiver (FTT-10a).
    - .3 The Johnson Controls N2 field bus.
  - .2 Control networks shall provide either “peer-to-peer,” master-slave, or supervised token passing communications, and shall operate at a minimum communication speed of 9600 baud.
  - .3 DDC controllers shall reside on the control network.
  - .4 Control network shall be capable of communicating in BACnet standard MS/TP bus protocol ASHRAE SSPC-135.

- .5 A BACnet protocol implementation conformance statement (pics) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP bus.
- .3 User Interface
    - .1 Dedicated web based user interface
      - .1 Provide ADX 10 server, which can accommodate up to 10 users, for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS network automation engines to facilitate greater fault tolerance and reliability.
      - .2 Dedicated user interface architecture – the architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS contractor and by other third party applications suppliers, including but not limited to Microsoft office applications. Specifically it must be implemented to conform to the following interface standards.
        - .1 Microsoft internet explorer for user interface functions
        - .2 Microsoft office professional for creation, modification and maintenance of reports, sequences other necessary building management functions
        - .3 Microsoft outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
        - .4 Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries
    - .2 Distributed web based user interface
      - .1 All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
      - .2 The software shall run on the Microsoft internet explorer (6.0 or higher) browser supporting the following functions:
        - .1 Configuration
        - .2 Commissioning
        - .3 Data archiving
        - .4 Monitoring
        - .5 Commanding
        - .6 System diagnostics
      - .3 Minimum hardware requirements:
        - .1 1gb ram
        - .2 2.0 ghz clock speed Pentium 4 microprocessor
        - .3 100 gb hard drive.
        - .4 1 keyboard with 83 keys (minimum).
        - .5 SVGA 1024x768 resolution display with 64k colors and 16 bit color depth
        - .6 Mouse or other pointing device

- .3 Site management user interface application components
  - .1 Operator interface
    - .1 An integrated browser based client application shall be used as the user operator interface program.
    - .2 The system shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.
    - .3 All inputs, outputs, setpoints, and all other parameters as defined within part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
    - .4 The user interface software shall provide help menus and instructions for each operation and/or application.
    - .5 The system shall support customization of the UI configuration and a home page display for each operator.
    - .6 The system shall support user preferences in the following screen presentations:
      - .1 alarm
      - .2 trend
      - .3 display
      - .4 applications
    - .7 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
    - .8 The operator interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
      - .1 user access for selective information retrieval and control command execution
      - .2 monitoring and reporting
      - .3 alarm, non-normal, and return to normal condition annunciation
      - .4 selective operator override and other control actions
      - .5 information archiving, manipulation, formatting, display and reporting
      - .6 BMS internal performance supervision and diagnostics
      - .7 on-line access to user help menus
      - .8 on-line access to current BMS as-built records and documentation
      - .9 means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications
  - .9 The system shall support a list of application programs configured by the users that are called up by the following means:
    - .1 the tools menu
    - .2 hyperlinks within the graphics displays
    - .3 key sequences

- .10 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.
- .2 Navigation trees
  - .1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
  - .2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
  - .3 The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the windows task bar. A simple keystroke will reattach the navigation to the primary display of the user interface.
- .3 Alarms
  - .1 Alarms shall be routed directly from network automation engines to servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
    - .1 log date and time of alarm occurrence.
    - .2 generate a “pop-up” window, with audible alarm, informing a user that an alarm has been received.
    - .3 allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
    - .4 provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
    - .5 provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
    - .6 configuration of which NAE offline alarms are seen by each user
    - .7 any attribute of any object in the system may be designated to report an alarm.
  - .2 The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
  - .3 The BMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined .wav files.
  - .4 The BMS shall annunciate application alarms at minimum, as required by part 3.

- 4 Reports and summaries
  - .1 Reports and summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
    - .1 all points in the BMS
    - .2 all points in each BMS application
    - .3 all points in a specific controller
    - .4 all points in a user-defined group of points
    - .5 all points currently in alarm
    - .6 all points locked out
    - .7 all user defined and adjustable variables, schedules, interlocks and the like.
  - .2 Summaries and reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined html pages.
  - .3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
  - .4 Provide the capability to view, command and modify large quantities of similar data in tailored summaries created online without the use of a secondary application like a spreadsheet. Summary definition shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported. Summary viewing shall be available over the network using a standard web browser.
  - .5 Provide a focused set of reports that includes essential information required for effective management of energy resources within the facility. Energy reports shall be configurable from predefined, preconfigured templates. Required includes but shall not be limited to:
    - .1 energy overview
    - .2 load profile
    - .3 simple energy cost
    - .4 consumption
    - .5 equipment runtime
    - .6 electrical energy
    - .7 energy production
  - .6 Reports shall be selectable by date, time, area and device. Each report shall include a color visual summary of essential energy information.
- 5 Schedules
  - .1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
    - .1 weekly schedules
    - .2 exception schedules
    - .3 monthly calendars
  - .2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

- .3 It shall be possible to define one or more exception schedules for each schedule including references to calendars
  - .4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
  - .5 Changes to schedules made from the user interface shall directly modify the network automation engine schedule database.
  - .6 Schedules and calendars shall comply with ASHRAE SP135/2008 BACnet standard.
  - .7 The calendar object supports an option to add a reference to another calendar object that is designated to be the master for the facility. Any supervisory and BAC calendars can be configured to reference a single master global calendar. Changes to the master global calendar are automatically synced with all calendars that are referenced.
  - .8 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
  - .9 Software shall be provided to configure and implement optimal start and stop programming based on existing indoor and outdoor environmental conditions as well as equipment operating history
  - .10 The system solar clock shall support the scheduling and energy management functions. The solar clock will calculate the sunrise, sunset, and sun angle values for a specified latitude and longitude. A time offset can also be specified. An example would be to use the solar clock object as a master to an interlock to turn lights on 30 minutes after sunset and off 30 minutes before sunrise.
- .6 Security/passwords
- .1 Multiple-level passwords access protection shall be provided via roles and permissions. The feature will allow the system to base access on a user's job title or role and allow the user/manager access interface control, display, and database manipulation capabilities based on an assigned password.
  - .2 Roles may be copied and altered to meet specific roles and permissions based on the particular policies.
  - .3 Each user shall have the following: a (Metasys local) user account name (with a maximum of 30 characters), a complex password or passphrase (with a min of 8 characters and a max of 50 characters), other user account policies (such as session timeout), timesheet access based on day of the week and time of day, and specific user view.
  - .4 The system shall allow each user to change his or her password at will.
  - .5 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

- .6 A maximum of 150 categories may be used to determine or assign areas of responsibilities to each user account. A maximum of 13 (of the 150) named categories which are specifics such as “no access, view, advanced review, operate, intervene, diagnostic, manage item events, manage every, and configure items”.
- .7 A minimum of 100 unique passwords shall be supported.
- .8 Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- .9 Operators shall be further limited to only access, command, and modify those buildings, systems, and subsystems for which they have responsibility. Provide a minimum of 100 categories of systems to which individual operators may be assigned.
- .10 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
- .11 The system shall have the ability to provide a department of defense (DOD) specific warning banner for applicable sites that warns the user they are accessing a restricted site.
- .12 After successful login to the site management portal (SMP) the last time and date that user name was previously logged in is shown on the screen.
- .13 Each login attempt is recorded in the system audit log with the option to record the IP address of the pc that made the login.
- .7 Screen manager
  - .1 The system will allow a customized image on the login screen (i.e. Organization name, logo).
  - .2 User view navigations can be displayed as either a set of tabs or a drop down list.
  - .3 Allows user preference for assigning of a background color for when an object is out of service which will enable the operator to quickly distinguish points that have been commanded to this state.
  - .4 The user interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
- .8 Dynamic color graphics
  - .1 The graphics application program shall be supplied as an integral part of the user interface. Browser or workstation applications that rely only upon html pages shall not be acceptable.
  - .2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to

- display and provide animation based on real-time data that is acquired, derived, or entered.
- .3 Graphics runtime functions – a maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
    - .1 all graphics shall be fully scalable
    - .2 the graphics shall support a maintained aspect ratio.
    - .3 multiple fonts shall be supported.
    - .4 unique background shall be assignable on a per graphic basis.
    - .5 the color of all animations and values on displays shall indicate the status of the object attribute.
    - .6 graphics that represent buildings or systems shall allow natural links and transitions between related detailed tabular views of data that compliment the graphic.
  - .4 Operation from graphics – it shall be possible to change values (setpoints) and states in system controlled equipment directly from the graphic.
  - .5 Floor plan graphics – the user interface shall provide graphic applications that summarize conditions on a floor. Floor plan graphics shall indicate thermal comfort using dynamic colors to represent zone temperature deviations from zone setpoint(s). Floor plan graphics shall display overall metrics for each zone in the floor.
  - .6 Aliasing – many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
  - .7 Graphic editing tool – a graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
    - .1 the graphic editing tool shall provide a library of standard HVAC equipment, floor plan, lighting, security and network symbols.
    - .2 the graphic editing tool shall provide for the creation and positioning of library symbols by dragging from tool bars or drop-downs and positioning where required.
    - .3 the graphics editing tool shall permit the importing of AutoCAD drawings for use in the system.
    - .4 the graphic editing tool shall be able to add additional content to any graphic by importing images in the svg, png or jpg file formats.
  - .9 Historical trending and data collection
  - .10 Each automation engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
    - .1 any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:

- .1 Defined time interval
      - .2 Upon a change of value
    - .2 each automation engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
  - .2 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
  - .3 The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in SQL database format.
  - .4 The system shall provide data to enable optimization capabilities including fault detection and diagnostics, advanced analytics and central plant optimization without the need of a gateway or additional hardware.
  - .5 Trend data viewing and analysis
  - .6 Provide a trend viewing utility that shall have access to all database points.
  - .7 It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
  - .8 The trend viewing utility shall have the capability to define trend study displays to include multiple trends
  - .9 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
  - .10 Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
  - .11 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
  - .12 The display shall support the user's ability to change colors, sample sizes, and types of markers.
- .11 Database management
  - .1 Where a separate SQL database is utilized for information storage the system shall provide a database manager that separates the database monitoring and managing functions by supporting two separate windows.
  - .2 Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the building automation application.
  - .3 The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

- .1 backup
- .2 purge
- .3 restore
- .4 The database manager shall support four tabs:
  - .1 statistics – shall display database server information and trend, alarm (event), and audit information on the Metasys databases.
  - .2 maintenance – shall provide an easy method of purging records from the Metasys server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.
  - .3 backup – shall provide the means to create a database backup file and select a storage location.
  - .4 restore – shall provide a restricted means of restoring a database by requiring the user to log into an expert mode in order to view the restore screen.
- .5 The status bar shall appear at the bottom of all Metasys database manager tabs and shall provide information on the current database activity. The following icons shall be provided:
  - .1 ready
  - .2 purging record from a database
  - .3 action failed
  - .4 refreshing statistics
  - .5 restoring database
  - .6 shrinking a database
  - .7 backing up a database
  - .8 resetting internet information services
  - .9 starting the Metasys device manager
  - .10 shutting down the Metasys device manager
  - .11 action successful
- .6 The database manager monitoring functions shall be accessed through the monitoring settings window and shall continuously read database information once the user has logged in.
- .7 The system shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- .8 The monitoring settings window shall have the following sections:
  - .1 general – shall allow the user to set and review scan intervals and start times.
  - .2 email – shall allow the user to create and review e-mail and phone text messages to be delivered when a warning or alarm is generated.
  - .3 warning – shall allow the user to define the warning limit parameters, set the reminder frequency, and link the e-mail message.
  - .4 alarm – shall allow the user to define the alarm limit parameters, set the reminder frequency, and link the e-mail message.

- .5 database login – shall protect the system from unauthorized database manipulation by creating a read access and a write access for each of the trend, alarm (event) and audit databases as well as an expert mode required to restore a database.
- .9 The monitoring settings taskbar shall provide the following informational icons:
  - .1 normal – indicates by color and size that all databases are within their limits.
  - .2 warning - indicates by color and size that one or more databases have exceeded their warning limit.
  - .3 alarm - indicates by color and size that one or more databases have exceeded their alarm limit.
- .10 The system shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- .12 Demand limiting and load rolling
  - .1 The system shall provide a demand limiting and load rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.
  - .2 The system shall support both sliding window and fixed window methods of predicting demand.
  - .3 The system shall support three levels of sensitivity in the sliding window demand calculations for fine tuning the system.
    - .1 low setting – sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.
    - .2 medium setting – sheds loads earlier over a longer amount of time than the low setting. Increases the time the equipment is on and decreases the probability of exceeding the tariff target over the low setting.
    - .3 high setting – sheds loads earlier over a longer amount of time than the medium setting. Minimizes the probability of exceeding the tariff target.
  - .4 The system shall have both a shed mode and a monitor only mode of operation.
    - .1 when the shed mode is engaged, the system shall actively control the demand.
    - .2 when the monitor mode is engaged, the system will simulate the shedding action but will not take any action.
  - .5 The demand limiting program shall monitor the energy consumption rate and compare it to a user defined tariff target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.
  - .6 The demand limiting program shall be capable of supporting a minimum of 10 separate load priorities. Each load shall be user assigned to a load priority.
  - .7 The demand limiting program shall be capable of supporting a minimum of 12 separate tariff targets defining the maximum allowed average power during the current interval.

- .8 The system shall support a maximum shed time for each load as determined by the user. The system shall restore the load before the maximum shed time has expired.
- .9 The system shall support a minimum shed time for each load as determined by the user. The system shall not restore the load sooner than the minimum shed time has expired.
- .10 The system shall support a minimum release time for each load as determined by the user. The system shall not shed the load until it has been off for the minimum release time.
- .11 The system shall support three user defined options if the meter goes unreliable.
  - .1 shedding – the currently shed loads will be released as their maximum shed times expire.
  - .2 maintain the current shed rate – the system will use the demand limiting shed rate that was present when the meter went unreliable.
  - .3 use unreliable meter shed rate – the system will control to a user defined unreliable shed rate target.
- .12 The load rolling program shall sum the loads currently shed and compare it to a user defined load rolling target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined load priority.
- .13 The load rolling program shall be capable of supporting a minimum of 10 separate load priorities. Each load shall be user assigned to a load priority.
- .14 The load rolling program shall be capable of supporting a minimum of 12 separate tariff targets defining the amount of power by which the demand must be reduced.
- .15 The system shall provide the user with a load tab that displays all of the demand limiting and load rolling parameters for any selected load.
- .16 The system shall provide the user with a load summary that displays all of the loads associated with the demand limiting and load rolling programs. Status icons for each load shall indicate:
  - .1 load is offline
  - .2 load is disabled
  - .3 load is shed
  - .4 load is locked
  - .5 load is in comfort override
- .17 The load summary shall include a load summary runtime view listing the following load conditions:
  - .1 load priority
  - .2 shed strategy
  - .3 load rating
  - .4 present value
  - .5 ineligibility status
  - .6 active timer
  - .7 time remaining
  - .8 last shed time

- 4 Network Automation Engines (NAE)
  - .1 Network automation engine (NAE 55xx)
    - .1 The network automation engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other network automation engines.
    - .2 Automation network – the NAE shall reside on the automation network and shall support a subnet of system controllers.
    - .3 User interface – each NAE shall have the ability to deliver a web based user interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
      - .1 The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
      - .2 The NAE shall support up a minimum of four (4) concurrent users.
      - .3 The web based user shall have the capability to access all system data through one NAE.
      - .4 Remote users connected to the network through an internet service provider (ISP) or telephone dial up shall also have total system access through one NAE.
      - .5 Systems that require the user to address more than one NAE to access all system information are not acceptable.
      - .6 The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
      - .7 Systems that support UI graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
      - .8 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
        - .1 configuration
        - .2 commissioning
        - .3 data archiving
        - .4 monitoring
        - .5 commanding
        - .6 system diagnostics
      - .9 Systems that require workstation software or modified web browsers are not acceptable.
      - .10 The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
    - .4 Processor – the NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this specification.
    - .5 Memory – each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

- .6 Hardware real time clock – the NAE shall include an integrated, hardware-based, real-time clock.
- .7 The NAE shall include troubleshooting led indicators to identify the following conditions:
  - .1 Power - on/off
  - .2 Ethernet traffic – ethernet traffic/no ethernet traffic
  - .3 Ethernet connection speed – 10 mbps/100 mbps/1000 mbps
  - .4 FC Bus A – normal communications/no field communications
  - .5 FC Bus B – normal communications/no field communications
  - .6 Peer communication – data traffic between NAE devices
  - .7 Run – NAE running/NAE in startup/NAE shutting down/software not running
  - .8 Bat fault – battery defective, data protection battery not installed
  - .9 24 VAC – 24 VAC present/loss of 24 VAC
  - .10 Fault – general fault
  - .11 Modem RX – NAE modem receiving data
  - .12 Modem TX – NAE modem transmitting data
- .8 Communications ports – the NAE shall provide the following ports for operation of operator input/output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
  - .1 Two (2) USB port
  - .2 Two (2) URS-232 serial data communication port
  - .3 Two (2) RS-485 port
  - .4 One (1) Ethernet port
  - .5 Diagnostics – the NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The network automation engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
- .9 Power failure – in the event of the loss of normal power, the NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
  - .1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into flash memory.
  - .2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
- .10 Certification – the NAE shall be listed by underwriters laboratories (UL).
- .11 Controller network – the NAE shall support the following communication protocols on the controller network:
  - .1 The NAE shall support BACnet standard ms/tp bus protocol ASHRAE sspc-135, clause 9 on the controller network.
    - .1 the NAE shall be BACnet testing labs (BTL) certified and carry the BTL label.
    - .2 the NAE shall be tested and certified as a BACnet building controller (B-BC).

- .3 a BACnet protocol implementation conformance statement shall be provided for the NAE.
- .4 the conformance statements shall be submitted 10 days prior to bidding.
- .5 the NAE shall support a minimum of 100 control devices.
- .2 The NAE shall support LonWorks enabled devices using the free topology transceiver FTT10.
  - .1 all LonWorks controls devices shall be LonMark certified.
  - .2 the NAE shall support a minimum of 255 LonWorks enabled control devices.
- .3 The NAE shall support the Johnson Controls N2 field bus.
  - .1 the NAE shall support a minimum of 100 N2 control devices.
  - .2 the bus shall conform to Electronic Industry Alliance (EIA) standard RS-485.
  - .3 the bus shall employ a master/slave protocol where the NAE is the master.
  - .4 the bus shall employ a four (4) level priority system for polling frequency.
  - .5 the bus shall be optically isolated from the NAE.
  - .6 the bus shall support the Metasys integrator system.

## 2.1 MATERIALS

- .1 All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the Departmental Representative's representative in writing. Spare parts shall be available for at least five years after completion of this contract.

## 2.2 COMMUNICATION

- .1 All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to *ANSI/ASHRAE Standard 135-2010, BACnet*.
- .2 Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this section.
- .3 The contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the internetwork.
- .4 All controllers shall have a communication port for connections with the operator interfaces using the BACnet Data Link/Physical layer protocol.
- .5 Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
  - .1 Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

- .2 All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.
- .6 The time clocks in all controllers shall be automatically synchronized daily via the internetwork. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the internetwork.
- .7 The internetwork shall have the following minimum capacity for future expansion:
  - .1 Each building controller shall have routing capacity for 50 controllers.
  - .2 The building controller network shall have capacity for 50 building controllers.
  - .3 The system shall have an overall capacity for 12,500 building controller, custom application controller, and application specific controller input/output objects.

### **2.3 OPERATOR INTERFACE**

- .1 Workstation information access shall use the BACnet protocol. Communication shall use the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol.
- .2 System Software
  - .1 System Graphics. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while online. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
  - .2 Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
  - .3 Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- .3 System Applications. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:
  - .1 Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each Building Controller. This database shall be updated whenever a change is made in any system panel. The storage of these data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel. This capability may be disabled by the operator.

- .2 Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
- .3 System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.
- .4 On-Line Help. Provide a context-sensitive, online help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
- .5 Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable. All system security data shall be stored in an encrypted format.
- .6 System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
- .7 Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
- .8 Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.
- .9 Alarm Reactions. The operator shall be able to determine (by object) what, if any, actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day.
- .10 Trend Logs. The operator shall be able to define a custom trend log for any data object in the system. This definition shall include interval, start time, and stop time. Trend data shall be sampled and stored on the building controller panel, be achievable on the hard disk, and be retrievable for use in spreadsheets and standard database programs.
- .11 Alarm and Event Log. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
- .12 Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.

- .13 Clock Synchronization. The system shall be able to automatically synchronize all system real-time clocks daily from any operator-designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.
- .14 Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archivable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.
- .15 Standard Reports. The following standard system reports shall be provided for this project. Provide ability for the Departmental Representative to readily customize these reports for this project.
  - .1 All Objects: All system (or subsystem) objects and their current values.
  - .2 Alarm Summary: All current alarms (except those in alarm lockout).
  - .3 Disabled Objects: All objects that are disabled.
  - .4 Alarm Lockout Objects: All objects in alarm lockout (whether manual or automatic).
  - .5 Alarm Lockout Objects in Alarm: All objects in alarm lockout that are currently in alarm.
  - .6 Logs:
    - .1 Alarm History
    - .2 System Messages
    - .3 System Events
    - .4 Trends
- .16 Custom Reports. Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.
- 4 Workstation Applications Editors. Each PC workstation shall support editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the controller panels.
  - .1 Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
  - .2 Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule. Schedules shall be easy to copy to other objects and/or dates.
  - .3 Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom

routines are edited, compiled, and downloaded. The programming language shall have the following features:

- .4 The language shall be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or “fill in the blanks”). Alternatively, the programming language can be graphically based using function blocks as long as blocks are available that directly provide the functions listed below and that custom or compound function blocks can be created.
- .5 A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.
- .6 The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
- .7 The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.
- .8 The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- .9 The programming language shall support floating-point arithmetic.
- .10 The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.
- .11 The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
- .12 The programming language shall have predefined variables representing the status and results of the System Software and shall be able to enable, disable, and change the set points of the System Software described below.

## **2.4 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 operator workstation.
- .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.
  - .4 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

- .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, optimal start, optimal stop, and night economizer. 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 Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
  - .3 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 System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.
- .5 Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
- .6 Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
- .7 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. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.
- .8 Remote Communication. The system shall have the ability to dial out in the event of an alarm.
- .9 Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.
- .10 Sequencing. Provide application software based upon the sequences of operation specified to properly sequence chillers, boilers, and pumps.
- .11 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, set point, and PID gains shall be user-selectable.
- .12 Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user-selectable.
- .13 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.
- .14 On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct-acting

or reverse-acting and incorporate an adjustable differential.

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

## **2.5 INPUT/OUTPUT INTERFACE**

- .1 Hardwired inputs and outputs may tie into the system through building, custom application, or application specific controllers.
- .2 All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.
- .3 Universal type input/output points shall be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.
- .4 Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.
- .5 Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.
- .6 Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with—and field configurable to—commonly available sensing devices.
- .7 Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
- .8 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- .9 System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

## **2.6 POWER SUPPLIES AND LINE FILTERING**

- .1 Control transformers shall be CSA approved. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with CEC requirements. Limit connected loads to 80% of rated capacity.
- .2 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component.

## **2.7 WIRING AND RACEWAYS**

- .1 General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.
- .2 All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 General
  - .1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Departmental Representative for resolution before rough-in work is started.
  - .2 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Departmental Representative for resolution before rough-in work is started.
  - .3 The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others the contractor shall report these discrepancies to the Departmental Representative and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.
  - .4 All items shall be installed in accordance with manufacturer's instructions. All conduit shall be independently supported from the structure in an approved manner.
  - .5 The control equipment and connecting conduit and wire shall be installed in a neat and workmanlike manner by personnel skilled in this type of installation. All tubing, conduit and plenum rated cable shall be run in an approved manner; conduit shall be run parallel to or at right angles to the building structure. All conduit, tubing, and plenum cable shall be concealed in all finished spaces. Conduit containing wire or non-metallic tubing may be installed exposed in mechanical rooms or areas where other piping is run exposed.
  - .6 Non-metallic tubing and plenum cable may be used in concealed accessible spaces provided such installation is allowed by local codes.
  - .7 All electrical work shall be installed by experienced personnel and conform to CEC and all local codes. Where requirements of Division 26 differ from those contained herein, Division 26 section shall take precedence.

### **3.2 GENERAL WORKMANSHIP**

- .1 Install equipment and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .3 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

### **3.3 BMS SPECIFIC REQUIREMENTS**

- .1 Graphic Displays
  - .1 Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
  - .2 User shall access the various system schematics via a graphical penetration scheme and/or menu selection.
- .2 Custom Reports:
  - .1 Provide custom reports as required for this project

### **3.4 INSTALLATION PRACTICES**

- .1 BMS Wiring
  - .1 All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
  - .2 All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
  - .3 The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
  - .4 Class 2 Wiring
    - .1 All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
    - .2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
  - .5 Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
  - .6 Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
- .2 BMS Line Voltage Power Source
  - .1 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.
  - .2 Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
  - .3 DDC terminal unit controllers may use AC power from motor power circuits.

- .3 BMS Raceway
  - .1 All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
  - .2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
  - .3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
  - .4 Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.
- .4 Penetrations
  - .1 Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
  - .2 All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
  - .3 All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
  - .4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- .5 BMS Identification Standards
  - .1 Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
  - .2 Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- .6 BMS Panel Installation
  - .1 The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
  - .2 The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

### **3.5 IDENTIFICATION OF HARDWARE AND WIRING**

- .1 All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.
- .2 Permanently label or code each point of field terminal strips to show the instrument or item served.
- .3 Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic nameplates.
- .4 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- .5 Identify room sensors relating to terminal box or valves with nameplates.

- .6 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- .7 Identifiers shall match record documents.

### **3.6 CONTROLLERS**

- .1 Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
- .2 Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points.

### **3.7 PROGRAMMING**

- .1 Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.
- .2 Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. All set-points and monitoring points shall be in metric units.
- .3 Software Programming:
  - .1 Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation.
- .4 Operator Interface
  - .1 Standard graphics—Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
  - .2 Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point shown.
  - .3 The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

### **3.8 CONTROL SYSTEM CHECKOUT AND TESTING**

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

### **3.9 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE**

- .1 Demonstration
  - .1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
  - .2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The Departmental Representative will be present to observe and review these tests. The Departmental Representative shall be notified at least 10 days in advance of the start of the testing procedures.

- .3 The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
  - .4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
  - .5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
  - .6 Demonstrate compliance with Part 1, "System Performance."
  - .7 Demonstrate compliance with sequences of operation through all modes of operation.
  - .8 Demonstrate complete operation of operator interface.
  - .9 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- .2 Acceptance:
- .1 All tests described in this specification shall have been performed to the satisfaction of both the Departmental Representative and Departmental Representative prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the Departmental Representative. Such tests shall then be performed as part of the warranty.
  - .2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

### **3.10 CLEANING**

- .1 Conform to Section 017411 Cleaning.
- .2 The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- .3 At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- .4 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

### 3.11 TRAINING

- .1 Provide training as indicated in Section 017900 Demonstration and Training.
- .2 Train the designated staff of Departmental Representative's representative and Departmental Representative to enable them to do the following:
  - .1 Day-to-day Operators:
    - .1 Proficiently operate the system
    - .2 Understand system operation, including DDC system control and optimizing routines (algorithms)
    - .3 Operate the workstation and peripherals
    - .4 Log on and off the system
    - .5 Access graphics, point reports, and logs
    - .6 Adjust and change system set points, time schedules, and holiday schedules
    - .7 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
    - .8 Understand system as-built drawings and Operation and Maintenance manual
    - .9 Understand the job layout and location of control components
    - .10 Access data from DDC controllers and ASCs
  - .2 Advanced Operators:
    - .1 Make and change graphics on the workstation
    - .2 Create, delete, and modify alarms, including annunciation and routing of these
    - .3 Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
    - .4 Create, delete, and modify reports
    - .5 Add, remove, and modify system's physical points
    - .6 Create, modify, and delete programming
    - .7 Add panels when required
    - .8 Add operator interface stations
    - .9 Create, delete, and modify system displays, both graphical and others
    - .10 Perform DDC system field checkout procedures
    - .11 Perform DDC controller unit operation and maintenance procedures
    - .12 Perform workstation and peripheral operation and maintenance procedures
    - .13 Perform DDC system diagnostic procedures
    - .14 Configure hardware including PC boards, switches, communication, and I/O points
    - .15 Maintain, calibrate, troubleshoot, diagnose, and repair hardware
    - .16 Adjust, calibrate, and replace system components System
  - .3 Managers/Administrators:
    - .1 Maintain software and prepare backups
    - .2 Interface with job-specific, third-party operator software
    - .3 Add new users and understand password security procedures

- .3 These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.
  - .1 Day-to-day Operators
  - .2 Advanced Operators
  - .3 System Managers/Administrators
  - .4 Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.
  - .5 The instructor(s) shall be factory-trained instructors experienced in presenting this material.
  - .6 Classroom training shall be done using a network of working controllers representative of the installed hardware.

### **3.12 COMMISSIONING**

- .1 Fully commission all aspects of the Building Management System work per Section 019113.
- .2 Acceptance Check Sheet
  - .1 Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.
  - .2 Submit the check sheet to the Departmental Representative for approval
  - .3 The Departmental Representative will use the check sheet as the basis for acceptance with the BMS Contractor.
- .3 Promptly rectify all listed deficiencies and submit to the Departmental Representative that this has been done.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2-15, Canadian Electrical Code, Part 2
  - .3 CAN/CSA-C22.3 No. 1, Overhead Systems.
  - .4 CAN3-C235-83, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
  - .5 CSA B651-12, Accessible design for the built environment.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1 EEMAC 2Y-1, Light Gray Colour for Indoor Switch Gear.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
  - .1 IEEE 100-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

**1.2 CONTRACTOR REQUIREMENTS**

- .1 Comply with all Department of Labour, Workplace and Health requirements at all times.
- .2 All Contractors shall have a valid Contractors license to operate in the City of Saskatoon.
- .3 The complete installation shall be carried out in neat and workmanlike manner to the satisfaction of the Consultant.
- .4 All Electrical Contractor employees on site shall have valid Trade Licenses.
- .5 Electrical Contractor shall maintain the appropriate ratio of Journeymen Electricians & Apprentices required by Provincial Codes. Only qualified workmen shall be employed on this contract. Supervision shall be by Journeymen Electricians and work carried out by Journeymen and/or registered apprentices only.
- .6 Obtain all necessary permits & pay all fees and arrange for inspection with City of Saskatoon.
- .7 Obtain a certificate of final inspection and approval from inspection department having jurisdiction on completion of work.
- .8 All materials, tools, appliances, scaffolding, apparatus and labour necessary for the execution, erection and completion of specified systems shall be furnished.
- .9 Provide all labour and materials necessary for complete and operating systems as indicated on the drawings and specified herein. Any work and material, even if not shown or specified, which is obviously necessary or reasonably implied to complete the work shall be provided as if it was both shown, and specified.
- .10 Unless otherwise specifically noted, any issues which are not part of electrical / telecommunication area of expertise, even if mentioned in these documents, are indicated only for reference and coordination purposes only (with other trades).

- .11 The Contractor shall consult with all other sub-trades involved to confirm the locations of the various outlets and equipment and shall cooperate fully to ensure that no conflict arises during the installation. In case of any difference of opinion, the matter shall be referred to the Consultant for final decision.
- .12 Contractor is responsible for arranging and coordinating with other divisions for proper drainage of electrical conducts entering from outside, drainage of all exterior electrical junction and pull boxes, sealing and waterproofing of all electrical penetrations; methods of firestopping, and envelope penetration.

### **1.3 DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE 100-2000.

### **1.4 DESIGN REQUIREMENTS**

- .1 All electrical design drawings, details and specifications are diagrammatic, and unless specifically noted by figured dimensions, indicate the general arrangement of receptacles, light fixtures, switches, risers, panels, etc. Any information involving accurate dimensions, shall be obtained from detailed dimensioned drawings or by actual measurements at the building. If doubt exists as to the final location, the Contractor shall contact the Consultant for clarification prior to installation. The location of switches, receptacles, outlets, etc., shall be coordinated with built-in units, Department Representative appliances and equipment, mechanical equipment, etc., as shown on the architectural and mechanical drawings and/or as existing.
- .2 Where space is indicated for future equipment, leave such space clear and install feeders and equipment pertaining to this contract in such a way that future equipment can be easily installed.
- .3 Operating voltages: to CAN3-C235.
- .4 Language operating requirements: provide identification nameplates and labels for control items in English.

### **1.5 PLANS**

- .1 The Contractor shall familiarize them self with the plans which show the approximate locations of outlets and apparatus. The right is reserved to make such changes in location as may be necessary to meet contingencies of construction. No extras will be allowed for such changes to any piece of electrical equipment, outlets, etc., unless the distance exceeds 3000mm.
- .2 Should a discrepancy appear between plans, specifications, or the actual conditions encountered on the site, which leaves the Contractor in doubt as to the true intention and meaning of the plans and specifications, a ruling shall be obtained in writing from the Consultant which will be final.

## 1.6 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings:
  - .1 Prior to manufacturing any item required for this job, the Contractor shall submit through the General Contractor, detailed shop drawings of the item. Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .2 Shop drawings must be received by the Consultant at a date early enough to permit reasonable study prior to review and manufacturer, or to permit alterations where necessary. Facsimile transmission of shop drawings will **NOT BE ACCEPTED**. Late submissions of shop drawings will be sufficient reason for stoppage of construction pending review, or removal and replacement of any unsatisfactory item at the Contractor's expense.
  - .3 Contractor shall allow a minimum of ten (10) business days for shop drawing review by the Consultant and time shall be incorporated in construction schedule so no delays occur due to late submission of shop drawings.
  - .4 Shop drawings shall to be submitted by email, bearing Contractors' signatures. All shop drawings shall be stamped by the Contractor and General Contractor prior to submission. Prints will be returned with review stamp and/or appropriate comments.
  - .5 Shop drawings shall be reviewed by the Consultant. Corrections or comments made on the shop drawings during this review do not relieve Contractor from compliance with requirements of the drawings and specifications. This review is only for the general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his or her work with that of all other trades and performing all work in a safe and satisfactory manner.
  - .6 Shop drawings shall be provided for all system components.
- .3 Quality Control:
  - .1 Any electrical material and/or equipment supplied by any Contractor or subcontractor for installation on this project must bear evidence of certification by authorized organization (e.g. CSA) or special certification acceptable to the Chief Inspector of Electrical Energy for the Province of Manitoba.
  - .2 Any material and/or equipment not complying with this requirement and found on the job site will be subject to rejection and replacement with approved equipment at no additional cost
  - .3 Contractor, upon receipt of equipment purchased by the Department Representative for installation on this project, shall examine it for compliance with the above requirements. Report any non approved equipment to the Consultant for action. Such equipment shall be returned to its packing crate until instructions are received from the Consultant, unless otherwise directed in writing by the Department Representative.
  - .4 Submit test results of installed electrical and telecommunication systems.
  - .5 Permits and fees: in accordance with General Conditions of contract.

- .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Department Representative.
- .4 Substitutions:
  - .1 Unless otherwise noted on the plans or specifications, substitutions may be allowed by the Consultant, when requested by the Contractor or by equipment suppliers, for items specified by manufacturer and catalogue number.
  - .2 Requests for review of such substitutions shall be submitted via email at least seven working days prior to the tender date. Facsimile transmission of substitution drawings and/or specifications will **NOT BE ACCEPTED**.
  - .3 Descriptive catalogue sheets accompanying the approval application which may show several items of varying specifications, shall be conspicuously marked in such a manner that the offered substitute item may easily be recognized for comparison.
  - .4 Proposed substitutions must be at least of equal quality to that of the specified item. The manufacturer's specification of the item shall apply for comparison if no other clause of this specification applies. The Department Representative will review substitution proposal, the Consultant will make final decision acting upon Department Representatives decision.
  - .5 Off-the-shelf items which are specified by description only, without any manufacturer, model type or catalogue number, do not require approval prior to the tender date. However, Contractor shall submit to the Consultant a request for review of such items prior to their use, in sufficient time to permit rejection if unsatisfactory.
  - .6 All additional expenses incurred as a result of substitution will be the direct responsibility of the Contractor.

## **1.7 QUALITY ASSURANCE**

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Acts respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

## **1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 11 - Cleaning.

## **1.9 SYSTEM STARTUP**

- .1 Instruct Operating Personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

## **Part 2 Products**

### **2.1 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

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

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

### **2.3 WARNING SIGNS**

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

### **2.4 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminium conductors.

### **2.5 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment, including but not limited to electrical panels, disconnect switches and motors, with nameplates and labels to match existing.

### **2.6 WIRING IDENTIFICATION**

- .1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring to match existing.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

### **2.7 PANEL SCHEDULES**

- .1 Update all panel schedules that are affected by this upgrade with new printed schedules.

**2.8 SINGLE LINE DIAGRAMS**

- .1 Provide AutoCAD single line diagram as-builts for all systems affected by this upgrade. The single line diagram shall show all connections as a result of this upgrade.

**2.9 CONDUIT AND CABLE IDENTIFICATION**

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals.

**Part 3 Execution****3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 The Contractor shall obtain and ascertain information from the Mechanical Controls Contractor as to the phasing and details of any additional electrical work to complete the building automation system upgrade. No extra claim will be accepted for work to upgrade the existing building automation system as specified in the mechanical plans and specifications.
- .3 Any electrical and communication work carried out on behalf of, or by, other contractors shall be in accordance with the regulations of the Canadian Electrical Code and the applicable clauses of this specification.
- .4 It shall be the General Contractor's responsibility to ensure that all subcontractors and suppliers of electrical equipment observe the applicable clauses of the electrical specifications.
- .5 In case of differences between Contractors regarding extent of work responsibilities, such matters shall be referred to the Consultant through the General Contractor. Should any discrepancy between the specification and drawings leave the Contractor in doubt as to the true intent and meaning, a ruling shall be obtained from the Consultant before the tender is submitted. If this is not done it will be the contractor's responsibility to ensure that the more expensive alternate has been included.
- .6 Before tendering, the Contractor shall visit the site and report to the Consultant any condition which might prevent him from performing his contract as specified. No extra will be allowed for if this procedure is not followed.
- .7 Should any work or material be needed which is not specified or shown on the drawings and is nevertheless necessary for properly carrying out the obvious intent, such work or materials shall be provided without additional cost.

**3.2 NAMEPLATES AND LABELS**

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

**3.3 MOUNTING HEIGHTS**

- .1 Mounting heights of equipment to be as per CSA B651-12.

**3.4 CO-ORDINATION OF PROTECTIVE DEVICES**

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

**3.5 FIELD QUALITY CONTROL**

- .1 Conduct the following quality control tests:
  - .1 Power distribution system including phasing, voltage and grounding.
  - .2 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .3 Systems: Structured Cabling.
  - .4 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
  - .5 Verify grounding impendence prior to connecting new equipment.
- .2 Carry out tests in presence of Departmental Representative.
- .3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

**3.6 CLEANING**

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

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Materials and installation for wire and box connectors.

**1.2                REFERENCES**

- .1            Canadian Standards Association (CSA International)
  - .1            CAN/CSA-C22.2 No.18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2            CSA C22.2 No.65, Wire Connectors.
- .2            Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1            EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3            National Electrical Manufacturers Association (NEMA)

**Part 2            Products**

**2.1                MATERIALS**

- .1            Pressure type wire connectors to: CSA C22.2 No.65, with current carrying parts of copper or copper alloy sized to fit copper or aluminum conductors as required.
- .2            Fixture type splicing connectors to: CSA C22.2 No.65, with current carrying parts of copper or copper alloy sized to fit copper conductors 10 AWG or less.
- .3            Clamps or connectors for armoured cable, aluminum sheathed cable, flexible conduit, non-metallic sheathed cable as required to: CAN/CSA-C22.2 No.18.Execution

**2.2                INSTALLATION**

- .1            Remove insulation carefully from ends of conductors and:
  - .1            Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
  - .2            Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
  - .3            Install fixture type connectors and tighten. Replace insulating cap.
  - .4            Install bushing stud connectors in accordance with NEMA.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1            Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

**1.2                PRODUCT DATA**

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

**1.3                SCOPE OF WORK**

- .1            Provide a complete system of wiring system, making all required connections as indicated on the drawings, specified herein and as required. Unless noted as larger, install and rate all cables and conductors in accordance with the requirements of the current edition of the Canadian Electrical Code.
- .2            Unless otherwise noted, all systems in the building shall be wired in conduit.

**Part 2            Products**

**2.1                WIRES**

- .1            Unless otherwise shown or specified, all conductors shall be 98% conductivity copper 600 volt "RW90" X-link insulated, and be of minimum size #12 AWG.
- .2            Provide cross-linked thermosetting polyethylene (RW90 X-link) type insulation for all fire alarm system conductors. Where run in cable form with outer jacket, insulation rating on individual conductors to be 105 degrees C.
- .3            Wiring drops for luminaires to be copper, #14 AWG flame retardant, heat and moisture resistant, rated at 600 volt, 125 degrees C Insulation.
- .4            All conductors to be copper only, unless otherwise noted.
- .5            Conductors up to #10 AWG may be solid. Conductors #8 AWG and above shall be stranded, unless specifically mentioned to be solid.
- .6            Equipment bonding conductors shall be insulated.

**2.2                CONNECTORS AND TERMINALS**

- .1            Use solderless, self-insulated connectors for hand twist wire joints for lighting, small power, heating and associated control devices.
- .2            Connectors #8 AWG gauge and larger shall be compression type.
- .3            Terminals shall be compression type with spade type lugs.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Conductor length for parallel feeders to be identical.
- .2 Lace or clip groups of feeder conductors at all distribution centres, pull boxes, panel boards and termination points.
- .3 All exterior wiring to be RW90 XLPE with 1000 volt insulation.
- .4 Provide permanent plastic name tag indicating load fed on all cable ends.
- .5 All home run wiring shall be done in concealed conduit or box as arrange for opening walls, ceiling and floors as necessary. The exceptions are:
  - .1 Norcom Modular Wiring and AC90 cables, that can be used for wiring light fixtures in the accessible suspended ceilings.
  - .2 AC90 cables, that can be used for wiring duplex and double duplex 15A and 20A receptacles in room such as offices, storages and corridors of low ceilings (up to 10 feet high), provided an accessible local area junction box located in the t-bar ceiling space of the particular room is installed to feed the receptacles, with home run conduit wiring from the j-box to panelboard. Typically each room shall have at least one such junction box with home run conduit,
  - .3 Wiremold 500 and other higher number wiremold wireways, for all surface mounted wiring on existing concrete and brick walls to receptacles when permitted by Department Representative,
  - .4 seal tight, for kitchen and mechanical equipment connections.,
  - .5 water tight conduits and fittings, for all exterior exposed connections.
- .6 Contractor shall ensure that all conduits and boxes are installed concealed in brick work, block work, furred out walls, steel stud and wood stud walls, unless specifically permitted. Any conduit installed on surface shall be removed and reinstalled concealed at Contractor's expense. All costs of making good walls and finishes will be borne by Contractor.
- .7 Nylon or similar pulling rope only shall be used to pull conductors into metallic and/or non-metallic conduit.
- .8 Exposed wiring, where permitted, shall be installed neatly, parallel or at right angles to the building lines.
- .9 An allowance shall be made for re-routing conduits where they go from ceiling to the wall, so they do not appear on side of beams.
- .10 No reduction is permitted on neutral conductors.
- .11 Only 2% voltage drop is permitted. Size wires to meet these requirements.

### 3.2 IDENTIFICATION OF CONDUCTORS

- .1 Line voltage conductors in conduit shall be colour coded to identify service voltage. Conductor colours for 120V circuits shall be:

120 Volt

- Phase A Red
- Phase B Black
- Phase C Blue
- Neutral White
- Ground Green

600V conductor colour to be confirmed with Consultant

- .2 Loop conductor in a three-way and four-way switching circuit shall be:

- Brown

- .3 Switch leg conductors of line voltage switches on lighting and any manually controlled plug receptacle circuits shall be colour coded as follows:

- A Yellow
- B Orange
- C Pink

The sequence of colours shall be repeated if more than three switch legs leave a switch box.

### 3.3 WORKMANSHIP

- .1 Before installing wire, ensure conduit is clean and dry. If moisture present, thoroughly dry out conduit; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type.
- .2 Installation to be free of opens and grounds. Before energization, megger each feeder to ensure that insulation resistance complies with C.E.C. requirements
- .3 Do not install any conductor smaller than #12 AWG gauge, except where specifically indicated otherwise.
- .4 Provide sizes of conductors as required by CEC or as indicated on the drawings. Voltage drop from panels to farthest device must not exceed 2% at full load. Voltage drop from the main distribution to the panel board must not exceed 2%.

### 3.4 Insulation Test

- .1 The insulation resistance between wires and between any wire and ground shall not be less than the "Canadian Electrical Code" requirements with all circuits complete and connected. Include tests results in maintenance manual.

**END OF SECTION**

**Part 1            General**

1.1            Not Used

**Part 2            Products**

**2.1            SUPPORT CHANNELS**

.1            U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted suspended set in poured concrete walls and ceilings.

**Part 3            Execution**

**3.1            INSTALLATION**

.1            Secure equipment to masonry, tile and plaster surfaces with lead shields. Use Aluminum shields or as approved by anchoring manufactures recommendations for specific surfaces.

.2            Secure equipment to poured concrete with 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.

.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 50 mm and smaller where above 2700mm.

.2            Two-hole steel straps to secure surface conduits and cables 50 mm and smaller where below 2700mm.

.3            Two-hole steel straps for conduits and cables larger than 50 mm.

.4            Beam clamps to secure conduit to exposed steel work.

.7            Suspended support systems.

.1            Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.

.2            Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.8            For surface mounting of two or more conduits use channels at 2 m 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.

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- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
  - .11 Luminaires Recessed in T-Bar ceilings shall be supported independent of T-Bar system via aircraft cable or "Gripple" hangers (Toggle or Y-Hook hangers) as manufactured by Cablofil and shall be firmly attached directly to the existing or new roof building structure.
  - .12 Do not use wire lashing or perforated strap to support or secure raceways or cables.
  - .13 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Department Representative.
  - .14 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

**END OF SECTION**

**Part 1 General**

**1.1 SHOP DRAWINGS AND PRODUCT DATA**

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

**Part 2 Products**

**2.1 JUNCTION AND PULL BOXES**

- .1 Sprinkler proof, welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

**2.2 CABINETS**

- .1 Type E: sprinkler proof, sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2 Type T: sprinkler proof, sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface or flush mounting as required.
- .3 All cabinets shall be sprinklerproof

**Part 3 Execution**

**3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install terminal block as required in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

**3.2 IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Install size 2 identification lamacoid labels indicating system name, voltage and phase.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23th Edition), Safety Standard for Electrical Installations.

**Part 2 Products****2.1 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1-15.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.
- .6 All electrical equipment shall be sprinkler proof.

**2.2 SHEET STEEL OUTLET BOXES**

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished tile walls.

**2.3 CONDUIT BOXES**

- .1 Cast FS or FD boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle. This is only allowed in mechanical spaces.

**2.4 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE**

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

**2.5 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 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

**END OF SECTION**

**Part 1            General**

**1.1                SCOPE OF WORK**

- .1        Provide conduit system as indicated herein, on the drawings and as required.
- .2        All new wiring shall be installed in conduit.

**Part 2            Products**

**2.1                CONDUITS**

**2.01              Rigid Steel Conduit**

- .1        Galvanized with threaded joints and connections.
- .2        Connections in dry locations: steel or malleable iron lock nuts inside and outside enclosures.
- .3        Connectors subject to moisture: Liquid and dust tight with insulated throat.
- .4        Fittings: steel
- .5        Do not use process piping in lieu of CSA approved conduit.

**2.02              EMT Conduit**

- .1        Fittings in dry locations: steel or malleable iron set screw type fastener with insulated throats or non-metallic bushings.
- .2        Fittings in wet locations: steel or malleable iron in rain tight, compression-type, with insulated throat or non-metallic bushings, this is typical for all exterior connections.

**2.03              Flexible Conduit**

- .1        Conduit: spiral wound, interlocking flexible.
- .2        Connectors: slip-proof insulated throat or non-metallic bushings, steel type.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Flexible Conduit shall be used for line and low voltage circuit connections to all motors or equipment subject to vibration and shall be metal PVC coated water tight, except for lighting fixture drops. Connectors shall be approved for flexible liquid tight conduits.
- .2        Unless otherwise noted, Electrical Metallic Tubing (EMT) - shall be utilized in the building.
- .3        Conduit for telecommunication and building automation systems shall be a minimum 21mm DIA unless noted as larger.
- .4        Install all conduit and wiring concealed, except where specifically noted otherwise.

- .5 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on racks.
- .6 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150mm from steam or hot water piping, etc.
- .7 All conduit exposed to weather shall approved for location and be complete with weatherproof fittings.
- .8 Where used, sleeves shall be c/w proper connectors and plastic bushing (this is particularly important for telecommunications and building automation system cabling installation.)
- .9 Install a separate ground wire in conduit installed underground or in concrete or masonry slab in contact with the earth.
- .10 Watertight fittings shall be installed in areas exposed to moisture and concrete type fittings in concrete slabs.
- .11 Where conduit is required to be bent, do not heat and do not bend in such a way as to reduce the cross-sectional area at any point.
- .12 For all runs of conduit, do not include more than the equivalent of four 90 degree bends, including bends located immediately adjacent to an outlet box or fitting. Provide pulling elbows, pull boxes and/or junction boxes where necessary.
- .13 Where possible, install conduits so that they are not trapped. Cap turned up conduits to prevent the entrance of any dirt or moisture during construction. If necessary, swab out conduit and thoroughly clean internally before wires and cables are pulled.
- .14 Take extreme care in reaming ends of all conduit to ensure a smooth, interior finish that will not damage the insulation of the wires.
- .15 Use insulated non-metallic bushings on all conduit terminators. Ensure electrical continuity in all conduit systems. All conduits shown exposed in finished areas are to be free of labels and trade marks. Install a 45kg test line in all empty conduits. Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used. Seal conduits with duct seal where conduits are run between heated and unheated areas or into freezers. Where conduits, cables, or cable trays pierce fire separations, seal openings with approved sealing compound.

### **3.2 SLEEVES AND CHASES**

- .1 Sleeves shall be provided and set for conduit passing through foundations, concrete walls and floors. Sleeves shall have sufficient diameter to allow free conduit movement resulting from thermal expansion and contraction. Sleeves installed through foundation walls, beams and footings shall be installed flush with walls, partitions, floors and ceilings. All sleeves installed below grade shall be caulked with oakum and lead on both sides of the wall. Sleeves in floors where water is present shall be caulked, graphite packing and water proof sealant used.

- .2 Exact locations of conduit stub ups for connection to service equipment, signs etc., shall be checked and verified with the Department Representative. Shop drawings shall be issued prior to rough-in and slab being poured.
- .3 No extra claim will be accepted for stub up adjustments as a result of the Contractor not following the checking procedure as described under item 2.
- .4 Adjustments of stub ups shall be carried out to the satisfaction of the Department Representative. Damaged surfaces shall be repaired to their original condition. Conduit extension shall comply with Canadian Electrical Code and wires are to be re-pulled.
- .5 For each telecommunication outlet (data, voice, video etc.) provide a corresponding sleeve in every wall leading to the local cable tray to facilitate installation of telecommunication cables.

### **3.3 EMPTY CONDUITS**

- .1 All empty conduits shall be c/w pull wires.
- .2 All conduits stubbed out shall be provided with rubber grommets and end caps.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1        Switches, receptacles, wiring devices, cover plates and their installation.

**1.2                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 26 05 00 - Common Work Results - Electrical.

**1.3                REFERENCES**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2        CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3        CSA-C22.2 No.55, Special Use Switches.
  - .4        CSA-C22.2 No.111, General-Use Snap Switches.

**1.4                SHOP DRAWINGS AND PRODUCT DATA**

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

**Part 2            Products**

**2.1                SWITCHES**

- .1        15 or 20 A, 120 V, single pole, three-way, or four-way switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111, commercial specification grade switches
- .2        Manually-operated general purpose ac switches with following features:
  - .1        Terminal holes approved for No. 10 AWG wire.
  - .2        Silver alloy contacts.
  - .3        Urea or melamine moulding for parts subject to carbon tracking.
  - .4        Suitable for back and side wiring.
  - .5        White toggle.
  - .6        Framed toggle
- .3        Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .4        Switches of one manufacturer throughout project.
- .5        Acceptable materials: Commercial Specification Grade.

## 2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R 5-20R and 6-50R, 125/250V V, 15/20/50 A, U ground, to: CSA-C22.2 No.42 with following features:
  - .1 White urea moulded housing for normal switches. Co-ordinate with Department Representative for all unique coloured receptacles.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Break-off links for use as split receptacles.
  - .4 Eight back wired entrances, four side wiring screws.
  - .5 Triple wipe contacts and riveted grounding contacts.
  - .6 Nylon face
  - .7 10 year warranty
- .2 Other receptacles with ampacity and voltage as indicated.
- .3 Receptacles of one manufacturer throughout project.
- .4 Acceptable materials: Commercial Specification Grade.

## 2.3 COVER PLATES

- .1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results - Electrical.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover plates:
  - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1     Not Used.

**1.2                REFERENCES**

- .1     Canadian Standards Association (CSA International)
  - .1     CSA-C22.2 No. 214, Communications Cables (Bi-National standard with UL 444).
- .2     Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
  - .1     TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.
  - .2     TIA/EIA-568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components.
  - .3     TIA/EIA-606-A, Administration Standard for the Commercial Telecommunications Infrastructure.

**1.3                SYSTEM DESCRIPTION**

- .1     Provide a new structured cabling system for the new building automation system consisting of unshielded-twist pair CAT5E cables, terminations, connectors, switch hardware and related equipment. The contractor shall be responsible for all terminations at the data outlets and patch panels.
- .2     Extend CAT5E cables between mechanical control cabinets and devices as per drawing H07 for a fully operational system. Where cable lengths exceed the distance limitations for CAT5E the Contractor shall provide repeater switches complete with lockable enclosure, 30 minute UPS backup and dedicated 120V line voltage power from a local panel board.

**1.4                SUBMITTALS**

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

**Part 2            Products**

**2.1                FOUR-PAIR 100  $\Omega$  BALANCED TWISTED PAIR CABLE**

- .1     Four-pair, 100 ohm balanced unshielded-twisted-pair (UTP) cable, flame test classification FT4 to: CSA-C22.2 No. 214, Category 5E to: TIA/EIA-568-B.2.

**2.2                WORK AREA UTP 4-PAIR MODULAR JACK**

- .1     Eight-position modular jack ("RJ-45"), type Category 5E to: TIA/EIA-568-B.2:
  - .1     Mounted in compatible single gang faceplate, flush entry, four jack positions per faceplate. Each port equipped with field installed "RJ-45" jacks, type Category 5E to: TIA/EIA-568-B.2.

**2.3            TERMINATION AND CROSS-CONNECTION HARDWARE FOR UTP**

- .1    IDC Terminal strips, 25 pair, for terminating multi pair 100  $\Omega$  balanced twisted pair cables and supporting cross-connections using jumper wires or compatible plug-ended patch cords: Category 5E to: TIA/EIA-568-B.2.
- .2    Mount or block for housing 12 IDC terminal strips, mounted on wall.
  - .1    Distribution rings or channels capable of externally mating with the above mount for managing cross-connection wires.
- .3    Each Patch panel, 2 rack units high, 24 ports:
  - .1    Each port equipped with field installed "RJ-45" jacks, type Category 5E to: TIA/EIA-568-B.2.
  - .2    Horizontal cable-management unit for every 24 ports.

**2.4            UTP PATCH CORDS**

- .1    3 meters long, with factory-installed male plug at one end to mate with "RJ-45" jack and with factory-installed male plug at other end to mate with "RJ-45" jack Category 5E, 4 pairs to: TIA/EIA-568-B.2.

**2.5            UTP WORK AREA CORDS**

- .1    3 meters long, each end equipped with "RJ-45" plug Category 5E to: TIA/EIA-568-B.2.

**2.6            ENCLOSURES**

- .1    All new equipment shall be located within enclosures.
- .2    Enclosures shall be wall mounted, hinged, lockable, and sized to suite the enclosed equipment, naturally ventilated and if required mechanically ventilated.
- .3    Finish: Black.

**Part 3           Execution**

**3.1            INSTALLATION OF TERMINATION AND CROSS-CONNECT HARDWARE**

- .1    Install termination and cross-connect hardware in rack as indicated and according to manufacturers' instructions. Identify and label as indicated to: TIA/EIA-606-A.
- .2    Install consolidation points, as indicated according to manufacturer's instructions. Identify and label as indicated to: TIA/EIA-606-A.

**3.2            INSTALLATION OF DISTRIBUTION CABLES**

- .1    Install cables in conduits and cable trays between mechanical control cabinets and devices as per drawing H07. Identify and label as indicated to: TIA/EIA-606-A.
- .2    Support horizontal cables at intervals not exceeding 2 meters.
- .3    Coil spare cables and store in ceiling space in zone.

### **3.3            INSTALLATION OF EQUIPMENT CABLES**

- .1    Install equipment cables in conduit or cable tray. Where equipment cables run within a concealed t-bar ceiling the equipment cables may be supported using J-hocks.
  - .1        Identify and label as indicated to: TIA/EIA-606-A.
- .2    Extend equipment cables between mechanical control cabinets and devices as per drawing H07. Drawing H07 is diagrammatically only and may not show all devices. Coordinate the exact connections with the Mechanical Controls Contractor.

### **3.4            TELECOMMUNICATIONS BONDING**

- .1    To standards:
  - .1        ANSI J-STD-607-A-2002, Joint Standard - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
  - .2        TIA/EIA-606-2002, Administration Standard for the Commercial Telecommunications Infrastructure.

### **3.5            COORDINATION**

- .1    The Contractor is responsible for coordinating all details and requirements with the Mechanical Controls Contractor.

### **3.6            FIELD QUALITY CONTROL**

- .1    Test horizontal UTP cables as specified below and correct deficiencies provide record of results as electronic record on CD.
  - .1        Perform tests for Permanent Link on installed cables, including spares: Category 5E using certified level III tester to: TIA/EIA-568-B.2.
  - .2        Perform tests for Channel on 100% of cross-connected data horizontal cabling installed from each telecommunications room, including shortest and longest drops from each telecommunications room.
- .2    Test backbone UTP cables as specified below and correct deficiencies: provide record of results as electronic record on CD.
  - .1        Perform tests for Permanent Link on 4-pair cables: Category 5E using certified level III tester to: TIA/EIA-568-B.2.
  - .2        Perform Wire Map tests on multi-pair UTP cables to: TIA/EIA-568-B.1.

**END OF SECTION**