
Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.
- .2 Related Requirements
 - .1 Section 01 91 13 – General Commissioning (Cx) Requirements.
 - .2 Section 01 91 33 – Commissioning Forms
 - .3 Section 01 91 41 – Commissioning Training
 - .4 Section 01 91 51 – Building Management Manual (BMM)

1.2 REFERENCES

- .1 American Water Works Association (AWWA)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA-13-13, Installation of Sprinkler Systems Handbook.
 - .2 NFPA-14-13, Automatic Sprinkler Systems Handbook.
 - .3 NFPA-20-13, Standard for the Installation of Stationary Fire Pumps for Fire Protection.
- .3 Public Works and Government Services Canada (PWGSC)
 - .1 PWGSC - Commissioning Guidelines CP.4 -3rd edition-03.
- .4 ASHRAE GUIDELINE 0, Commissioning Process.
- .5 CSA Z320-11 (Building Commissioning).

1.3 GENERAL

- .1 Provide a fully functional facility:
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 Facility user and O M personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
- .2 Term "Cx" in this section means "Commissioning".
- .3 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.

- .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
- .3 Sets out deliverables relating to O M, process and administration of Cx.
- .4 Describes process of verification of how built works meet [Owner/Investor's] [design] requirements.
- .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
- .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.
 - .2 General description of elements that make up Cx Plan.
 - .3 Process and methodology for successful Cx.
- .4 Acronyms:
 - .1 Cx - Commissioning.
 - .2 BMM - Building Management Manual.
 - .3 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.

1.4 DEVELOPMENT OF 100% CX PLAN

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

1.5 REFINEMENT OF CX PLAN

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

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:
 - .1 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 Being dedicated 100% to Cx activities only.
 - .2 Coordinate with the Departmental Representative the Cx activities.
 - .3 Demonstrations of equipment and systems.
 - .4 Training performance and submit lesson plans for approval.
 - .5 Performance testing.
 - .6 Coordinate with contractors to perform static checks and complete commissioning forms.
 - .7 Submit for approval a commissioning schedule.
 - .8 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation contractor/subcontractor:
 - .1 Equipment and systems except as noted.
 - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
 - .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
 - .4 Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
 - .5 Client: responsible for intrusion and access security systems.
 - .6 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O M personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.

- .2 Changes to heating or cooling loads beyond scope of EMCS.
- .3 Changes to EMCS control strategies beyond level of training provided to O M personnel.
- .4 Redistribution of electrical services.
- .5 Modifications of fire alarm systems.
- .6 Modifications to voice communications systems.
- .7 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

- .1 Commission mechanical and electrical systems and associated equipment without restriction to the present list:
 - .1 Plumbing systems:
 - .1 Domestic CWS and HWS;
 - .2 Regular sanitary waste systems;
 - .3 Gas piping;
 - .4 Oil piping;
 - .5 Submersible pumps;
 - .6 Circulation drinking water;
 - .7 Water heater;
 - .8 Backflow device;
 - .9 Sewage pumps.
 - .2 HVAC and exhaust systems:
 - .1 HVAC systems;
 - .2 General exhaust systems;
 - .3 Heat recovery systems;
 - .4 Geothermal system;
 - .5 Low heating system;
 - .6 Thermal power plant (chiller, boilers, heat pumps);
 - .7 Chilled water system (primary / secondary);
 - .8 Glycol network (hot/cold).
 - .3 Fire and life safety systems:
 - .1 Fire pumps, including transfer switches and controllers.
 - .2 Wet pipe sprinkler systems.
 - .3 Dry pipe sprinkler systems.
 - .4 Fuel storage in an aboveground tank.
 - .5 Fire extinguishers.
 - .4 Noise and vibration control systems for mechanical systems.
 - .1 Pumps;

- .2 Fans.
- .3 Chillers, heat pumps, cooling tower and Fan coils
- .5 Seismic restraint and control measures.
- .6 IAQ environmental control systems:
 - .1 Indoor conditions in areas indicated on plans.
 - .2 Indoor air quality (IAQ) in project areas according to actual standards.
 - .3 Environmental control systems in areas of the project.
- .7 EMCS:
 - .1 Equipment and material: including workstations, building inspectors and local instrumentation;
 - .2 Sequences verification;
 - .3 Calibration.
- .2 Commission electrical systems and equipment:
 - .1 Low voltage below 750 V:
 - .1 Low voltage equipment.
 - .2 Low voltage distribution systems.
 - .2 Emergency power generation systems:
 - .1 Generators.
 - .2 Fuel systems.
 - .3 Transfer switchgear and controllers.
 - .4 Uninterruptible power systems.
 - .3 Lighting systems:
 - .1 Lighting equipment.
 - .2 Distribution systems.
 - .3 Emergency lighting systems, including battery packs.
 - .4 Fire exit emergency signage.
 - .5 Lighting control system.
 - .4 Fire alarm systems, equipment:
 - .1 Fire alarm system multiplex.
 - .2 Annunciators.
 - .3 Control panels.
 - .4 Fire alarm battery banks.
 - .5 Other systems:
 - .1 Intrusion alarm
 - .2 Video monitoring
 - .3 Access control
 - .4 Intercom

1.9 DELIVERABLES RELATING TO O M PERSPECTIVES

- .1 General requirements:
 - .1 Compile French 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.

1.10 DELIVERABLES RELATING TO THE CX PROCESS

- .1 General:
 - .1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2 Definitions:
 - .1 Cx as used in this section includes:
 - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
 - .2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Tests of following witnessed by PWGSC Design Quality Review Team:
 - .1 Equipment and systems supplied and installed by specialized subcontractors.
 - .2 HVAC system including but not limited to:
 - .1 Chillers;
 - .2 Heat pumps;

- .3 Cooling Tower;
- .4 Pumps;
- .5 Humidifiers;
- .6 Ventilation systems;
- .7 Heat recovery systems;
- .8 Fluid networks;
- .3 Compressors
- .4 Wet and dry pipe automatic sprinkler systems;
- .5 Fire alarm system;
- .6 Generator;
- .7 Lighting control system;
- .8 Domestic water heater;
- .9 Fuel management system;
- .10 Training Plans.
- .11 Cx Reports.
- .12 Prescribed activities during warranty period.
- .4 Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative.
- .5 Departmental Representative to participate.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: by Departmental Representative prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
 - .2 Departmental Representative to use approved check lists.
 - .3 Departmental Representative will monitor some of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and does not form part of Cx specifications.
 - .6 Departmental Representative will monitor some of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - MECHANICAL:
 - .1 Plumbing systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 Complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

- .2 HVAC equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Departmental Representative.
- .3 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".
- .3 Pre-Cx activities - LIFE SAFETY SYSTEMS
 - .1 Include equipment and systems identified above.
 - .1 Fire alarm system;
 - .2 Generator;
 - .3 Sprinkler system.
 - .2 Reports of test results to be witnessed and certified by Departmental Representative before verification.
- .4 Pre-Cx activities - ELECTRICAL:
 - .1 Low voltage distribution systems under 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
 - .2 Emergency power generation systems
 - .1 Transfer switches: test by simulating loss of power. Verify availability of power at equipment requiring same.
 - .2 Uninterruptible power systems: test under full and partial load conditions.

- .3 Lighting systems:
 - .1 Emergency lighting systems:
 - .1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.
 - .4 Fire alarm systems: test after other safety and security systems are completed. Testing to include a complete verification in accordance with ULC requirements. Departmental Representative has witnessed and certified report, demonstrate devices and zones to Departmental Representative.
 - .5 Low voltage systems: these include:
 - .1 Clock, communications, low voltage lighting control systems and data communications systems.

1.12 START-UP

- .1 Start up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
 - .1 Generator;
 - .2 Chillers;
 - .3 Water tower;
 - .4 Air conditioner;
 - .5 Ventilation unit;
 - .6 Wet and dry pipe automatic sprinkler systems;
 - .7 Fire alarm system;
 - .8 Lighting control system.
- .3 Departmental Representative to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative.
- .4 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Departmental Representative.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Departmental Representative to witness and certify reported results using approved PI and PV forms.
 - .4 Departmental Representative to approve completed PV reports and provide to Departmental Representative.
 - .5 Departmental Representative reserves right to verify up to 30% of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.13 CX 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 HVAC and associated systems forming part of integrated HVAC systems;
 - .2 Chilled water systems;
 - .3 Heating systems;
 - .4 Domestic water networks;
 - .5 Systems related to Indoor air quality;
 - .6 Environmental space conditions systems;
 - .7 Fire alarm systems;
 - .8 Fire pumps and controllers;
 - .9 Emergency power generator;
 - .10 Transfer switch and controllers;
 - .11 Emergency lighting systems;
 - .12 Low voltage lighting systems.
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance Departmental Representative and Cx Manager to co-operate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.14 INSTALLATION CHECK LISTS (ICL)

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

1.15 PRODUCT INFORMATION (PI) REPORT FORMS

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

1.16 PERFORMANCE VERIFICATION (PV) REPORT

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

1.17 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 SCHEDULES

- .1 Prepare detailed critical path Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
 - .1 Design criteria, design intents.
 - .2 Pre-TAB review: 28days after contract award, and before construction starts.
 - .3 Cx agents' credentials: 60 days before start of Cx.
 - .4 Cx procedures: 3 months after award of contract.
 - .5 Cx Report format: 3months after contract award.
 - .6 Discussion of heating/cooling loads for Cx: 3 months before start-up.
 - .7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
 - .8 Notification of intention to start TAB: 21 days before start of TAB.
 - .9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
 - .10 Notification of intention to start Cx: 14 days before start of Cx.
 - .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14days before start of integrated system Cx.
 - .12 Identification of deferred Cx.
 - .13 Implementation of training plans.
 - .14 Cx of smoke management/control systems: after Cx of related systems is completed and 7 days before proposed date of Cx these systems.
 - .15 Cx reports: immediately upon successful completion of Cx.
 - .16 Emergency evacuation exercises: after 80% occupancy and at same time as Cx of stair shaft pressurization systems.
 - .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.
 - .3 6 months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Consultant, Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.

1.19 CX SCHEDULE FOR MECHANICAL SYSTEMS

- .1 Produce schedule of Cx activities in bar chart format to a scale that will ensure legibility. Bar chart to indicate:
 - .1 Sequences of testing equipment and systems, interrelationship between tests, duration of tests and training periods.
 - .2 Cx resources which will be committed to this project to ensure completion by prescribed dates.
 - .3 Training Plan.
 - .4 Cx Documentation Plan.
- .2 Water/fire mains and related site fire hydrants:
 - .1 Commission as soon as installation is complete, using procedures described in NFPA reference standards to provide protection for exterior envelope of new building during construction.
- .3 New incoming water mains:
 - .1 Commission when temporary heat is available.
- .4 Fire and hose standpipe systems:
 - .1 Temporary fire hose cabinets to be provided by Contractor.
 - .2 Install and provide fire protection during construction, but to be commissioned after building has been closed in.
 - .3 Test completed systems in accordance with NFPA 14.
- .5 Wet pipe and dry pipe sprinkler systems:
 - .1 Test completed systems in accordance with NFPA 13 and CSA Z320.11.
- .6 Fire pumps, jockey pumps, transfer switches and controllers:
 - .1 Test in accordance with NFPA 20 13 and CSA Z320.11.
 - .2 Verify jockey pumps have sufficient capacity to prevent repeated starts of fire pumps.
- .7 Integrated fire protection systems:
 - .1 Upon completion of individual system tests, test integrated systems to verify that components work together as designed.
 - .2 After fire alarm connections are completed and fire pumps and jockey pumps have been commissioned, conduct flow tests of sprinkler systems.
- .8 High pressure steam and condensate mains from central heating and cooling plant (CHCP):
 - .1 To permit use of CHCP steam for temporary heat. Steam condensate to be returned to CHCP.
 - .2 Commission as soon as modifications to same have been completed [and as soon as new addition has been closed in and use of temporary heat has been approved and is possible.
 - .3 Cx to be under direction of CHCP staff.

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- .9 Plumbing systems:
 - .1 To be filled, pressure booster pumps "bumped" in a stand-alone mode and pre-start-up inspections completed. Then proceed with flushing, cleaning and disinfection processes.
 - .2 Test plumbing and piping systems in conjunction with related water treatment systems and control systems.
 - .10 HVAC systems:
 - .1 Ductwork, piping and conduit systems to be concealed and tested and certified to specified standards before being concealed. This work is specified in relevant technical sections of Division 23.
 - .2 HVAC systems to be initially started up, "bumped" in a stand-alone mode and pre-start-up inspections completed.
 - .3 Start after dust-producing construction procedures have been completed and areas are dust-free.
 - .4 Start HVAC to replace temporary heating systems after Departmental Representative's written approval.
 - .5 Operate HVAC to permit TAB and ensure full compliance with contract documents when weatherstripping, caulking and sealing of exterior envelope has been completed, and interior partitions and doors are installed and ceiling return plenums are in place.
 - .11 Clean-steam humidification systems:
 - .1 Commission after relevant water treatment systems have been commissioned.
 - .12 Hydronic systems:
 - .1 To be filled, pumps "bumped" in stand-alone mode and pre-start-up inspections completed. Then undertake cleaning and flushing processes.
 - .2 Commission after exterior envelope has been completed and exterior has been caulked, but only after relevant water treatment systems have been commissioned.
 - .3 Commission at same time as HVAC systems are being TAB'd.
 - .13 HVAC and related hydronic systems:
 - .1 Test in conjunction with EMCS, and fire and smoke detection systems.
 - .14 Items which have a detrimental effect on operation and maintenance. To receive preliminary attention at this point. To be fully commissioned at same time as relevant equipment and systems.
 - .1 Integrated systems:
 - .1 Performance of HVAC, fire protection, EMCS and systems forming part of integrated systems to be verified after systems has been TAB'd to ensure compliance with prescribed requirements.
 - .2 Equipment and systems subject to specified codes and standards or subject to approval of an authority having jurisdiction:

- .1 Commission equipment and systems in accordance with those requirements.
 - .2 Where testing is required as part of a regulatory process, and where Cx procedures are fully developed, are appropriate to project, ensure tests as required by such codes are performed. Departmental Representative to witness tests as part of Quality Assurance role.
- .15 EMCS:
- .1 Testing and Cx to be specified in Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning, which defines conditions for acceptance.
 - .2 Point-by-point and end-to-end testing to be carried out by installation Contractor, monitored by Departmental Representative and verified as part of system verification.
 - .3 Demonstration of operation of systems under operating conditions and over full operating range to take place prior to 30-day test period and to be witnessed by Departmental Representative. Includes simulated opposite-season tests. EMCS programming and operation to be verified after HVAC systems have been TAB'd and to include specified 30-day test period.
- .16 Full-scale emergency evacuation tests of entire facility:
- .1 To be carried out during early stages of Warranty Period using procedures and protocols developed during Cx phase.
- .17 Indoor Air Quality (IAQ):
- .1 Tests to be carried out where identified.
- .18 Space environmental conditions:
- .1 Tests to be carried out where identified.
- .19 To reduce VOC concentrations to acceptable levels:
- .1 Flow rates of outside air into HVAC systems to be adjusted as required during Cx, after occupancy and as necessary after occupancy.
- .20 Final Cx activities:
- .1 Upon completion of Cx to satisfaction of Departmental Representative lock control devices in their final positions, indelibly mark settings and include in TAB and PV Reports.
- .21 Thermal and electrical power and energy required for Cx in form of electrical load banks, CHCP steam and CHCP chilled water:
- .1 Will be provided free of cost to Contractor who is responsible for equipment and system operation and maintenance.
 - .2 Disposal of unwanted energy in an environmentally safe manner to be discussed during development of Cx schedule.

1.20 CX SCHEDULE FOR ELECTRICAL SYSTEMS

- .1 Systems to be tested as required by codes:

- .1 Where testing is required as part of a regulatory process and where Cx procedures are developed and are appropriate to project, perform tests as required by such codes.
- .2 Departmental Representative to witness these tests as part of Quality Assurance role.
- .2 Produce a schedule of Cx activities in a bar chart format to a scale that will ensure legibility. Bar chart to indicate:
 - .1 Sequences of testing equipment and systems, interrelationship between tests, duration of tests and training periods.
 - .2 Cx resources which will be committed to this project to ensure completion by prescribed dates.
 - .3 Training plan.
 - .4 Cx documentation plan.
- .3 Main distribution system:
 - .1 Testing and Cx to be defined in construction specifications.
 - .2 Contractor to conduct "megger" tests of feeders.
 - .3 Cx to utilize services of an independent testing agency to perform a series of pre-energization and post-energization tests.
- .4 Low voltage systems:
 - .1 These include clock, PA communications, low voltage lighting and data communications systems.
- .5 Emergency power systems:
 - .1 Testing and Cx of emergency generator, transfer switch and controllers to be included in construction specification.
 - .2 Test transfer switches by simulating loss of normal power.
 - .3 Verify power available at equipment requiring emergency power.
- .6 Uninterruptible power systems:
 - .1 Test these systems under load in accordance with procedures prescribed in construction specifications.
- .7 Emergency lighting systems:
 - .1 Perform tests by interrupting normal power.
 - .2 Thereafter verify adequacy of coverage.
- .8 Fire alarm systems:
 - .1 Verify operation of these systems after aspects of life safety and security systems are complete.
 - .2 Testing to be monitored by Departmental Representative and include complete verification in accordance with ULC and CSA Z320-11 requirements.

- .3 After receipt by Departmental Representative of Cx Report, Cx specialist to demonstrate devices and zones to Cx Manager, Project Manager and Property Manager.
- .9 Intrusion alarm systems and networks.
- .10 Video monitoring systems and networks.
- .11 Access control systems and networks.
- .12 Intercom systems and networks.
- .13 Cx requirements to be included in construction specifications.

1.21 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.

1.22 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.

1.23 TRAINING PLANS

- .1 Refer to Section 01 91 41 - Commissioning (Cx) - Training]

1.24 FINAL SETTINGS

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

1.25 PAYMENTS FOR CX

- .1 Should be done in two payments, the first one at the substantial completion and the second at the end of the warranty.

END OF SECTION