

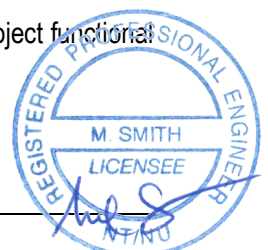
## 1. GENERAL

### 1.1 Summary

- .1 Section includes:
  - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to FPT of components, equipment, sub-systems, systems, and integrated systems.
- .2 Related Requirements
  - .1 Section 01 91 31 – Commissioning Plan;
  - .2 Section 01 91 33 – Commissioning Forms;
  - .3 Section 01 91 41 – Commissioning Training;
  - .4 Section 01 91 51 – Building Management Manual;
  - .5 Section 25 01 11 – EMCS: Start-Up, Verification and Commissioning.
- .3 Acronyms:
  - .1 BMM - Building Management Manual.
  - .2 Cx - Commissioning.
  - .3 EMCS - Energy Monitoring and Control Systems.
  - .4 O&M - Operation and Maintenance.
  - .5 PI – Product Information
  - .6 FPT - Functional Performance Testing
  - .7 TAB - Testing, Adjusting and Balancing.
  - .8 CxA – Commissioning Authority.

### 1.2 General

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
  - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
  - .2 Ensure appropriate documentation is compiled into the BMM.
  - .3 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
  - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
  - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user's requirements.
- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.



### 1.3 Commissioning Overview

- .1 Section 01 91 31 - Commissioning (Cx) Plan.
- .2 For Cx responsibilities refer to Section 01 91 31 - Commissioning (Cx) Plan.
- .3 Cx to be a line item of Contractor's cost breakdown.
- .4 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities include transfer of critical knowledge to facility operational personnel.
- .6 Departmental Representative will issue Interim Acceptance Certificate when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative and CxA.
  - .2 Equipment, components, systems, and interaction between those systems have been commissioned.
  - .3 O&M training has been completed.

### 1.4 Non-Conformance to Performance Verification Requirements

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the non-functional system, including related systems as deemed required by Departmental Representative and CxA, to ensure effective performance.
- .2 Cost 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 and CxA.
    - .1 Adequacy of provisions for Cx.
    - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
  - .1 Coordinate 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 and systems are 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 and CxA for approval.
- .7 Have Cx schedule up-to-date.
- .8 Ensure systems have been cleaned thoroughly.
- .9 Complete TAB procedures on systems; submit TAB reports to Departmental Representative and CxA for review and approval.
- .10 Ensure "As-Built" system schematics are available.
- .11 Inform Departmental Representative and CxA in writing of discrepancies and deficiencies on finished works.

#### 1.6 Conflicts

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

#### 1.7 Action and Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit no later than four (4) weeks after award of Contract:
    - .1 Name of Contractor's Cx agent accompanied with a list a relevant projects realized by that person.
    - .2 Draft Cx documentation.
    - .3 Preliminary Cx schedule.
- .2 Request in writing to Departmental Representative and CxA for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
- .3 Submit proposed Cx procedures to Departmental Representative and CxA were not specified and obtain written approval at least 8 weeks prior to start of Cx.
- .4 Provide additional documentation relating to Cx process required by Departmental Representative and CxA

#### 1.8 Commissioning Documentation

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

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**1.9 Commissioning Schedule**

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with ~~Section 01 32 16.06~~ Construction Progress Schedule - Critical Path Method (CPM).
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
  - .1 Approval of Cx reports.
  - .2 Verification of reported results.
  - .3 Repairs, retesting, re-commissioning, re-verification.
  - .4 Training.

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**1.10 Commissioning Meetings**

- .1 Convene Cx meetings following project meetings: ~~Section 01 32 16.06~~ Construction Progress Schedule - Critical Path Method (CPM) and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage. ~~Section 01 32 16.06~~ Construction Progress Schedule - Critical Path Method (CPM). Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
  - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
  - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by the Contractor's Cx Agent, who will record and distribute minutes.
- .7 CxA will call for Cx meetings when deemed necessary or to coordinate specific issues.
- .8 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

**1.11 Starting and Testing**

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

**1.12 Witnessing of Starting and Testing**

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

- .3 Departmental Representative will witness some tests and/or will ask that tests be repeated if required.
- .4 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

#### 1.13 Manufacturer's Involvement

- .1 Factory testing: manufacturer to:
  - .1 Coordinate time and location of testing.
  - .2 Provide testing documentation for approval by Departmental Representative and CxA.
  - .3 Arrange for Departmental Representative to witness tests.
  - .4 Obtain written approval of test results and documentation from Departmental Representative and CxA 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 and CxA:
  - .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 manufacturers 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.

#### 1.14 Procedures

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
  - .1 Included in delivery and installation:
    - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
    - .2 Visual inspection of quality of installation.
  - .2 Start-up: follow accepted start-up procedures and Manufacturer's recommendation.
  - .3 Operational testing: document equipment performance.
    - .1 System FPT: include repetition of tests after correcting deficiencies.
    - .2 Post-substantial performance verification: to include fine-tuning.
    - .3 Seasonal testing: to include full-load and partial load verification based on seasonal environmental conditions (i.e: summer, winter).

- .3 Correct deficiencies and obtain approval from Departmental Representative and CxA after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved FPT forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
  - .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative and CxA.
  - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative and CxA.
  - .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
    - .1 Rejected equipment to be removed from site and replace with new.
    - .2 Subject new equipment/systems to specified start-up procedures.

#### 1.15 Start-up Documentation

- .1 Assemble start-up documentation and submit to Departmental Representative and CxA 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 and CxA to repeat start-up at any time.

#### 1.16 Operation and Maintenance of Equipment and Systems

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit Departmental Representative and CxA for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

#### 1.17 Test Results

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

**1.18 Start of Commissioning**

- .1 Notify Departmental Representative at least 21 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

**1.19 Instruments/Equipment**

- .1 Submit to Departmental Representative and CxA for review and approval:
  - .1 Complete list of instruments proposed to be used.
  - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
  - .1 2-way radios.
  - .2 Ladders.
  - .3 Equipment as required to complete work.

**1.20 Commissioning Performance Verification**

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

**1.21 Witnessing Commissioning**

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

**1.22 Authorities Having Jurisdiction**

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

**1.23 Commissioning Constraints**

- .1 It is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

- .2 In case it is not possible to complete full load testing because of environmental conditions (i.e. test the full load of boilers in the summer), provisions must be made to perform those tests during the course of the year before final acceptance.

#### 1.24 **Extrapolation of Results**

- .1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by Departmental Representative in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.
- .2 Article 1.24.1 excludes the heating system and all of its components for which no extrapolation will be permitted.

#### 1.25 **Extent of Verification**

- .1 Provide manpower and instrumentation to verify up to 30 % of reported results, unless specified otherwise in other sections.
- .2 Number and location to be at discretion of Departmental Representative and CxA.
- .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .4 Review and repeat commissioning of systems if inconsistencies found in more than 20 % of reported results.
- .5 Perform additional commissioning until results are acceptable to Departmental Representative and CxA.

#### 1.26 **Sundry Checks and Adjustments**

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

#### 1.27 **Deficiencies, Faults, Defects**

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

#### 1.28 **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 and CxA.

#### 1.29 **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.

#### 1.30 **Training**

.1 In accordance with Section 01 91 41 - Commissioning (Cx) - Training.

#### 1.31 **Maintenance materials, Spare Parts, Special Tools**

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

#### 1.32 **Occupancy**

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

#### 1.33 **Installed Instrumentation**

.1 Use instruments installed under Contract for TAB and FPT if:

.1 Accuracy complies with these specifications.

.2 Calibration certificates have been deposited with Departmental Representative.

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

#### 1.34 **Performance Verification Tolerances**

.1 Application tolerances:

.1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.

.2 Instrument accuracy tolerances:

.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

.1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

**1.35 Owner's Performance Testing**

- .1 Performance testing of equipment or system by Departmental Representative and CxA will not relieve Contractor from compliance with specified start-up and testing procedures .

**2. PRODUCTS**

**NOT USED.**

**3. EXECUTION**

**NOT USED.**

**End of Section**

## 1. GENERAL

### 1.1 Summary

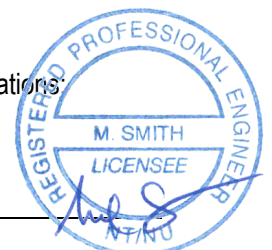
- .1 Section Includes:
  - .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

### 1.2 Related Requirements

- .1 Section 01 91 33 – Commissioning Forms;
- .2 Section 01 91 41 – Commissioning Training;
- .3 Section 01 91 51 – Building Management Manual;
- .4 Section 25 01 11 – EMCS: Start-Up, Verification and Commissioning.

### 1.3 References

- .1 American Water Works Association (AWWA)
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA-13-02, Installation of Sprinkler Systems Handbook.
  - .2 NFPA-14-02, Automatic Sprinkler Systems Handbook.
  - .3 NFPA-20-03, Standard for the Installation of Stationary Fire Pumps for Fire Protection.
- .3 Public Works and Government Services Canada (PWGSC)
  - .1 PWGSC - Commissioning Guidelines CP.1 -3rd edition-[06].
- .4 ASHRAE Guideline 0-2005 – The Commissioning Process;
- .5 ASHRAE Guideline 1.1-2007 – HVSC&R Technical Requirements for the Commissioning Process;
- .6 NIBS Guideline 3-2006 – Exterior Enclosure Technical Requirements for the Commissioning Process;
- .7 ASHRAE Guideline 4-2008 – Preparation of Operating and Maintenance Documentation for Building Systems;
- .8 ASHRAE Guideline 5-1994 Commissioning Smoke Management Systems;
- .9 ASHRAE Guideline 11-2009 – Field Testing of HVAC Controls Components;
- .10 ASHRAE 202-2013 – Commissioning process for Building and System
- .11 CSA Z320-2011 – Building Commissioning Standard
- .12 Portland Energy Conservation Inc. – Model Commissioning Plan and Guide Specifications;





- .13 SMACNA HVAC Systems Commissioning Manual;
- .14 NEBB Procedural Standards for Whole Building Systems Commissioning of New Construction;
- .15 ~~LEED® Canada 2009 – Reference Manual;~~
- .16 PWGSC General Procedures and Standards (GP&S).
- .17 Underwriters' Laboratories of Canada (ULC)

#### 1.4 General

- .1 Provide a fully functional facility:
  - .1 Interaction between Systems, 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 Describe process of verification of how built works meet Owner Project Requirements (OPR) and 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 SV – Static Verification
  - .7 OV – Operational Verification.
  - .8 TAB - Testing, Adjusting and Balancing.
  - .9 WHMIS - Workplace Hazardous Materials Information System.
  - .10 CxA – Commissioning Authority

- .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.

#### 1.5 Development of 100% Cx Plan

- .1 Cx Plan 95% complete.
- .2 Cx Plan to be 100% complete at least 12 weeks before the start of Cx.
  - .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. Project construction team's and Cx team's requirements.
- .3 Submit 100% complete Cx Plan to Departmental Representative and CxA and obtain written approval.

#### 1.6 Refinement of Cx Plan

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

#### 1.7 Composition, Roles and Responsibilities of Cx Team

- .1 Departmental Representative to maintain overall responsibility for project. The CxA will act as a 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 processes are developed in the Cx Plan by the Prime Consultant to deliver a fully operational project.
  - .3 Departmental Representative and CxA are responsible for:
    - .1 Organizing Cx and developing Cx documentation.
    - .2 Monitoring of Cx activities, training, and development of Cx documentation.
    - .3 Witnessing, verifying accuracy of reported results.
    - .4 Witnessing and verifying TAB and other tests.

- .5 Developing BMM.
- .6 Implementation of Training Plan.
- .7 Ensuring implementation of final Cx Plan.
- .8 Testing and verification procedures and sequences of operation for commissioning the equipments, systems and integrated systems must be reviewed and approved by the design consultant before the test and after the test.
- .9 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
- .10 Performing verification of performance of installed systems and equipment.
- .11 Work closely with members of Cx Team.
- .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 Departmental Representative and PWGSC Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx of Construction Team 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.

## 1.8 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.
- .2 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:
  - .3 Modify ventilation rates to meet changes in off-gassing.

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

1.9 **Extent of Cx (system list on Appendix A of this section & specific Cx plan on Appendix B on this section)**

- .1 Commission mechanical systems and associated equipment:
  - .1 Plumbing systems:
    - .1 Domestic CWS and HWS (including emergency water system).
    - .2 Regular sanitary waste systems.
    - .3 Sump pumps.
    - .4 Fuel oil with tank for heating system and main tank.
  - .2 HVAC and exhaust systems:
    - .1 HVAC systems.
    - .2 Exhaust systems and related systems.
    - .3 Heat recovery systems.
  - .3 Fire and life safety systems:
    - .1 ~~Special fire suppression systems identified herein:~~
      - .1 ~~Pre-action system.~~
    - .2 ~~Fire pumps, including transfer switches and controllers.~~
    - .3 Wet pipe sprinkler systems.
    - .4 Dry pipe sprinkler systems.
    - .5 Hose systems
    - .6 Fire extinguishers.
  - .4 Noise and vibration control systems for mechanical systems.
    - .1 HVAC acoustical level to be measured
  - .5 Seismic restraint and control measures.
    - .1 On equipments where required as specified.
  - .6 EMCS: All.
- .2 Commission electrical systems and equipment:
  - .1 Medium voltage:
    - .1 Medium voltage switch gear and transformation equipment.
    - .2 Medium voltage distribution system.
  - .2 Low voltage below 750 V:
    - .1 Low voltage equipment.
    - .2 Low voltage distribution system.
    - .3 Central clock system.
    - .4 Voice communications system.
    - .5 Communications structure cabling information system.

- .3 Lighting systems:
  - .1 Lighting equipment.
  - .2 Distribution system.
  - .3 Emergency lighting system, including battery packs.
  - .4 Fire exit emergency signage.
  - .5 Automatisation and control system.
- .4 Fire alarm systems, equipment:
  - .1 Annunciators.
  - .2 Control panels.
  - .3 Fire alarm battery banks.
  - .4 Fire alarm components.
- .5 Other systems and equipment:
  - .1 Intrusion, access control and video-surveillance systems.
  - .2 Grounding and ground fault system.

#### 1.10 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 prepared on client's form and followed client's specifications.
  - .5 WHMIS information.
  - .6 MSDS data sheets.
  - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.
  - .8 Preventive maintenance program.
  - .9 Contractor's and sub-contractors' as-built drawings.

#### 1.11 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:
  - .1 Cx Specifications.
  - .2 Startup, pre-Cx activities and documentation for systems, and equipment.



- .3 Completed installation checklists and static verification forms (SV).
- .4 Completed product information (PI) report forms. – on client's form for maintenance purpose.
- .5 Completed Functional Performance Testing (FPT) report forms and operational verification forms (OV).
- .6 Results of Performance Verification Tests and Inspections.
- .7 Cx Issues Log.
- .8 Tests procedures
- .9 Recommissioning manual
- .10 Test Data Reports
- .11 Description of Cx activities and documentation.
- .12 Description of Cx of integrated systems and documentation.
- .13 Tests witnessed by Departmental Representative.
- .14 Training Plans.
- .15 Cx Reports.
- .16 Prescribed activities during warranty period.

#### 1.12 Pre-Cx Activities and Related Documentation

- .1 Items listed in this Cx Plan include the following:
  - .1 Pre-Start-Up inspections: 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.
  - .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 days test period During this period, provide graphics and registered data every week, with variations curves on parameters chosen to demonstrate stability and performance of each system.
  - .6 Additional tests to be completed as "Off-Season Tests" or differed tests for weather sensitive systems.
- .3 Pre-Cx activities - ELECTRICAL:
- .1 Medium voltage distribution systems
  - .2 Low voltage distribution systems under 750 V:
    - .1 Requires independent testing agency to perform pre-energization and post-energization tests.
  - .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.
  - .5 Low voltage systems: these include:
    - .1 Clock, communications, low voltage lighting control systems and data communications systems.
  - .6 Security, surveillance and intrusion alarm systems: to include verification by Departmental Representative.
  - .7 Grounding and ground fault systems

### 1.13 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: All.
- .3 Departmental Representative to monitor some of these start-up activities.
  - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative.
- .4 Functional Performance Testing (FPT):
  - .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 verify reported results using approved static and operational verification forms.
  - .4 Contractor's Cx agent to approve completed FPT (operational verification) 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 operational and performance report or report of system startup and testing.

#### 1.14 Cx Activities and Related Documentation

- .1 Perform Cx using procedures developed by ASHRAE, NEBB, SMACNA, or any known organization related to the application of Cx process and approved by the Departmental Representative.
- .2 Departmental Representative to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved operational and performance verification forms.
- .4 Contractor Cx agent 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.

#### 1.15 Cx of Integrated Systems and Related Documentation

- .1 Cx to be performed by Cx specialist, using procedures developed by ASHRAE, NEBB, SMACNA, or any known organization related to the application of Cx process and approved by Departmental Representative. Cx specialist will follow also the Cx specific plan for each system prepared by Departmental Representative.
- .2 Required presence and support of Contractor and sub-contractors specialists during testing of integrated systems. These tests will start after all static and operational verifications of individual equipments and systems will be completed.
- .3 Duration of tests for integrated systems: 5 days.
- .4 Tests of integrated systems will follow protocols to be prepared by Departmental Representative in accordance with sequences of operation, see article 3.1.3, section 25 01 11.
- .5 Tests to be witnessed by Contractor Cx agent and documented on approved report forms.
- .6 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Contractor Cx agent and submitted to Departmental Representative for review.
- .7 Departmental Representative reserves right to verify percentage of reported results.
- .8 Integrated systems to include:
  - .1 HVAC and associated systems forming part of integrated HVAC systems.
  - .2 Indoor air quality.
  - .3 Indoor ambient parameters.
  - .4 Environmental space conditions.
  - .5 Fire alarm systems
  - .6 ~~Fire pumps and controllers.~~

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- .7 Voice communications systems.
- .8 Emergency lighting systems.
- .9 Test of integrated systems will follow different status to verify systems' respond on multiple loops:
  - .1 **Normal operation (occupied / unoccupied mode):**
    - .1 Variation of set points on HVAC systems;
    - .2 Measurements of indoor ambient parameters (temperature, relative humidity, noise, vibration) and indoor air quality (CO2);
    - .3 Measurements of pressure differential according to pressurisation drawings;
    - .4 Status for sprinkler system, ~~fire pump~~ and fire alarm system – diagram and graphics;
    - .5 Status for lighting – diagram and graphics;
    - .6 Status for voice communication systems;
    - .7 Status for access control and intrusion doors, diagram and graphics;
    - .8 Measured values, reports and graphics to be obtained from BAS.
  - .2 **Emergency status during fire alarm detection:**
    - .1 Status for generator with ventilation system including dampers;
    - .2 Verification of HVAC systems to be off as per sequences of operation;
    - .3 Verification of fume hoods, operating as per sequences of operation;
    - .4 Verification of control access components interlocked with fire alarm system
    - .5 Verification of status for elevators;
    - .6 Verification of alarms sent to BAS and to security post. All emergency procedures to be prepared by others;
    - .7 Verification of emergency lighting systems, measurements to respect minimum lighting level for security and corridor issues;
    - .8 Verification of voice communication systems.
  - .3 **Electrical power failure mode:**
    - .1 Verification of status for HVAC systems;
    - .2 Verification of status for boilers and components;
    - .3 Verification of status for elevators;
  - .4 **Alarm detection:**
    - .1 Maintenance alarms - report from BAS for all equipments base building during commissioning process;
    - .2 Emergency alarms – alarms sent to security post and / or remote to central, phone, mobile.
- .10 Identification:
  - .1 In later stages of Cx, before hand-over and acceptance Departmental Representative, Contractor, Project Manager, Property Manager and CxA 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. Contractor shall prepare all forms on client's data sheet format (to be available) using identification codes provided by PWGSC. Each equipment has to be identified with MMS code, on lamicoid plate, as per client's requirements

## 1.16 Installation Check Lists

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists.

- .2 Refer to Appendix B, section 01 91 31 – Commissioning Specific Plan, static verification (SV) forms.

#### 1.17 Product Information (PI) Report Forms

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Product Information (PI) Forms.
- .2 Refer to client's data sheet to be completed for maintenance purpose

#### 1.18 Functionnal Performance Testing (FPT) Report

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Functionnal Performance Testing (FPT) Forms.
- .2 Refer to Appendix B, section 01 91 31 – Commissioning Specific Plan, operational verification (OV) forms.
- .3 Refer to Section 25 01 11 – Start-up, verification and commissioning, for 30 days test, trends and detailed graphic curves.

#### 1.19 Deliverables Relating to administration of Cx

- .1 General:
  - .1 Complete Cx of occupancy, weather and seasonal-sensitive equipment and systems and provide a full operational test in real weather conditions. Document all these different tests and transmit to Departmental Representative to complete O&M Manual.

#### 1.20 Cx Schedules

- .1 Prepare detailed critical path Cx Schedule and submit to Departmental Representative for review and approval at the same time as project Construction Schedule. Include:
  - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
    - .1 Design criteria, design intents.
    - .2 Pre-TAB review: 90 days 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: 3 months 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: to begin 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 14 days before start of integrated system Cx.
    - .12 Identification of deferred Cx.
    - .13 Implementation of training plans.
    - .14 Cx reports: immediately upon successful completion of Cx.

- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Departmental Representative, Contractor and Contractor's Cx agent will monitor progress of Cx against this schedule.

#### 1.21 Cx Reports

- .1 Submit reports of tests, witnessed and certified by Contractor's Cx agent to Departmental Representative who will verify reported results.
- .2 Include completed and certified FPT reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Departmental Representative.
- .4 Cx Reports include: static and operational verification forms, tests for integrated systems and all tests provided by Manufacturers on their own forms.

#### 1.22 Preliminary and Final Cx

- .1 Preliminary Cx process is considered completed when all the deliverables related to pre-operational and operational tests will be completed and the documents will be received from the contractors.
- .2 Final Cx process is considered completed when the 30 days EMCS reports will be received and verified by Departmental Representative.

#### 1.23 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.
  - .4 Differed tests with participation of all required sub trades in technical specifications.

#### 1.24 Tests to be Performed by Owner/User

- .1 None.

#### 1.25 Training Plans

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

**1.26 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.

**End of Section**

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## **APPENDIX A – SYSTEMS LIST**



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## **APPENDIX B – SPECIFIC Cx PLANS**

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## **APPENDIX C – OWNER’S PROJECT REQUIREMENTS (OPR)**

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## **APPENDIX D – BASIS OF DESIGN (BOD)**

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## **APPENDIX E – COMMISSIONING TEAM ORGANIZATIONAL DIAGRAM**

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## **APPENDIX F – Cx SCHEDULE**

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## **APPENDIX G– SPECIFIC Cx PLANS AND REPORTS**