

1 GENERAL

1.1 SUMMARY

- .1 Section Includes
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
- .2 Acronyms
 - .1 CxA – Commissioning Authority.
 - .2 Cx – Commissioning.
 - .3 Cx Plan – Commissioning Plan.
 - .4 EMCS – Energy Monitoring and Control Systems.
 - .5 O&M – Operation and Maintenance.
 - .6 PV – Performance Verification.
 - .7 TAB – Testing, Adjusting and Balancing.
 - .8 GC – General Contractor
 - .9 TSI – Technical Services Inspector
 - .10 LEED - Leadership in Energy and Environmental Design

1.2 COMMISSIONING INTENT

- .1 Undertake Cx to bring the facility to a fully operational state and free of deficiencies in the most effective and timely manner available.
- .2 Cx incorporates inspection and quality assurance activities as construction progresses, including start up and demonstration, performance verification, fine tuning, and operator training.
- .3 Bear all costs associated with the required personnel and test equipment as outlined in specification sections and all costs with organizing and managing the activities of the applicable subtrades as identified in this section.
- .4 Fully document all tests and inspections performed during the construction, at start up, and during performance verification and fine tuning. Incorporate into final commissioning documentation.
- .5 Provide direct training to designated staff responsible for the operation and maintenance of the building equipment and systems.

1.3 RELATED SECTIONS

- .1 Section 01 45 00 - Quality Control.
- .2 Section 01 77 00 - Closeout Procedures.

- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 01 91 33 - Commissioning (Cx) Forms.
- .5 Section 01 91 41 - Commissioning (Cx) Training.

1.4

COMMISSIONING OVERVIEW

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project.
- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .3 Cx is conducted in concert with activities performed during each stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities include transfer of critical knowledge to facility operational personnel.
- .4 Complete inspection and verification activities as required by the specifications as construction progresses. This includes those activities that are necessary to ensure that the project is substantially complete to permit the execution of the commissioning process for the project.
- .5 Take responsibility to:
 - .1 Review the documentation manuals with the commissioning team.
 - .2 Complete all items as identified in these manuals. This includes work by subcontractors, test agencies, equipment representatives and manufacturer agents.
 - .3 Review Contract Documents and inspect the Work to ensure completeness of the Work and compliance with the Contract Documents.
 - .4 Correct contract deficiencies and execute change orders as directed by the Departmental Representative.
 - .5 Test, adjust and balance equipment and systems identified in Divisions 2-16.
 - .6 Submit the completed manuals and project record documents as specified.
 - .7 Update the documentation manuals prior to each project meeting.
- .6 The Substantial Completion Certificate will not be issued until the commissioning process is completed and the final reports and commissioning documentation are received.
- .7 The Cx Plan provides direction for the Cx process during design and construction, provides resolution for issues such as scheduling, roles and responsibilities, lines of communication and reporting, approvals and coordination.

1.5 **COMMISSIONING TEAM**

- .1 The commissioning team shall consist of:
 - .1 Department Representative(s)
 - .1 Design Manager (DM)
 - .2 Construction Manager (CM)
 - .3 Project Coordinator (PC)
 - .4 Engineer/Architect/Consultant (AE)
 - .5 Technical Services Inspectors (TSI)
 - .2 User Representatives/Owner.
 - .3 General Contractor (GC)
 - .4 Mechanical Contractor
 - .5 Controls Contractor (CC)
 - .6 Electrical Contractor
 - .7 Fire Alarm Contractor
 - .8 Commissioning Authority (CxA)
 - .9 Manufacturer's Technicians.
 - .10 Testing Agencies.
 - .11 Building Manager (BM)
 - .12 A/E - Architect and Design Engineers
- .2 Roles of the commissioning team shall be as follows:
 - .1 CxA (Commissioning Authority):
 - .1 Produces Cx manual.
 - .2 Provides "Issued for Construction" Cx manual to CM.
 - .3 Clarifies Cx team responsibilities.
 - .4 Attends Cx kickoff meeting.
 - .5 Attends periodic Cx progress meetings.
 - .6 Attends verification/testing demonstrations.
 - .7 Attends owner training sessions.
 - .8 Reviews completed Cx manual.
 - .9 Issues final copy of Cx manual for Owner to CM.
 - .2 DM (Design Manager):
 - .1 Identifies Cx team.
 - .2 Reviews Cx manual.
 - .3 Attends Cx verification/testing demonstrations or provides representative
 - .4 CM (Construction Manager):
 1. Main contact for CxA during construction phase.
 2. Distributes "Issued for Construction" Cx Manual to GC.

3. Notifies CxA of any Cx related issues raised during construction.
 4. Provides times during any project meetings to discuss Cx with the entire team.
 5. Holds Cx kickoff meeting .
 6. Coordinates Cx schedule with GC and ensures all parties are available to witness testing.
 7. Ensures Cx Team is following/completing Cx Manual.
 8. Coordinates training schedules.
 9. Reviews project record documents.
 10. Ensures that O&M manuals, maintenance materials, as-built drawings and warranties have been submitted and reviewed.
 11. Provides CxA with reviewed as-builts, O&M manuals, and warranties.
- .3 BM (Building Manager):
- .1 Coordinates maintenance staff participation in Cx activities.
 - .2 Reviews O&M documentation and attends training.
- .4 GC (General Contractor):
- .1 Maintains as-built drawings on site during construction.
 - .2 Executes the Cx process ensuring that Subs trades perform their responsibilities and integrate Cx into the construction process.
 - .3 Ensures equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform startups.
 - .4 Coordinates and schedules Cx activities with CM.
 - .5 Provides written confirmation all systems are operational prior to verification/demonstration.
 - .6 Conducts installation and performance verification with CxA (or designated representative).
 - .7 Maintains an up to date version of the Cx manual on site with checklists completed on installed/operational systems.
 - .8 Provides CM with all appropriate training, O&M manuals, maintenance material and spare parts and warranties.
 - .9 Obtains occupancy approvals/permits.
- .5 PC (Project Coordinator):
- .1 Attends installation verification and performance verification demonstrations.
 - .2 Ensures Cx manual is on site and kept up to date by the GC.
 - .3 Verifies maintenance materials are provided by the GC as per the contract documents.
 - .4 Ensures GC is maintaining as-built drawings on site during construction.

- .6 TSI (Technical Services Inspector):
 - .1 Attends installation verification and performance verification for equipment within their discipline.
 - .2 Signs off on Cx checklists within their discipline.
- .7 Sub Trades:
 - .1 Demonstrates correct system performance.
- .8 A/E:
 - .1 Provides system descriptions, project narrative and reviews Cx process to meet the design intent.

1.6 **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 Engineer/Architect, 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.

1.7 **CONFLICTS**

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

1.8 **SUBMITTALS**

- .1 Prior to starting Cx the Contractor shall provide a set of equipment and system submittals. These submittals are supplemented by the installation and start-up procedures, O&M data, performance data, control drawings and any changes that may affect commissioned systems.
- .2 Submit no later than 4 (four) weeks after award of Contract:
 - .1 Name of Contractor's Cx coordinator.
 - .2 Preliminary Cx schedule. Submit final Cx schedule to CxA for review prior to performance verification.
- .3 Ensure certified trades persons, certified testing agencies and/or factory authorized personnel participate in commissioning tasks.

- .4 Submit the names of all personnel for approval by the CxA. Designate who has managerial responsibilities for coordination of installation verification and performance verification.
- .5 Submit documentation to confirm personnel compliance with quality assurance provision.
- .6 Submit TAB report to CxA for review.
- .7 Submit start-up documentation to CxA for review.
- .8 Fifteen days prior to application for Substantial Completion:
 - .1 Submit 3 copies of final commissioning manual and applicable forms to the CM for review.
 - .2 Submit reports of performance verification postponed due to seasonal, climatic, occupancy, or other reasons beyond the Contractor's control, promptly after execution of those services.
 - .3 Ensure each form bears the required signatures as indicated on the form.
 - .4 Submit as-built drawings, schematics, O&M manuals, maintenance materials and warranties to CM for review.

1.9

COMMISSIONING DOCUMENTATION/checklists

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms for requirements and instructions for use.
- .2 Checklists will be provided to the Contractor by the CM during the construction stage.
- .3 Installing subcontractors are to date and initial the checklists as construction and start-up is completed.
- .4 The general contractor is to submit completed checklists to the CxA for review and acceptance.
- .5 Once all documents have been reviewed and accepted the general contractor shall submit final commissioning documents in electronic form (PDF) and original signed copies.

1.10

COMMISSIONING SCHEDULE

- .1 Submit preliminary Cx schedule no later than 4 weeks after award of contract. Submit final Cx schedule in Gantt Chart format to CxA for review prior to performance verification.
- .2 Provide adequate time for Cx activities prescribed in technical sections, commissioning sections and the Cx manual including all on site activities as well as documentation procedures. Time should be allowed for re-verification should any system be rejected upon completion of initial verification.

- .3 Provide adequate time for training.

1.11 COMMISSIONING MEETINGS

- .1 Commissioning Scope meeting:
- .1 The CM will convene Cx scope meeting consisting of all members of the design, construction and operations teams to address building systems to be commissioned. Items to be discussed will include commissioning requirements, completion and start-up schedules, and roles and responsibilities.
 - .2 Commissioning Authority (CxA) to make necessary updates and changes to the Commissioning Manual and deliver to the CM who will distribute to all other parties as necessary.
 - .3 Convene Cx meetings following project meetings and as specified herein to resolve issues, monitor progress and identify deficiencies relating to Cx.
 - .4 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
 - .5 At 60% construction completion stage CM 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.
 - .6 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
 - .7 Meeting will be chaired by the CM. Contractor will record minutes and submit to CM for review and approval. Approved minutes will be returned to the Contractor.
 - .8 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.12 STARTING AND TESTING

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

1.13 WITNESSING OF STARTING AND TESTING

- .1 Provide 21 days notice prior to commencement.
- .2 Owner's Representative to witness start-up and testing.
- .3 Contractor's Cx Coordinator to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.14 **MANUFACTURER'S INVOLVEMENT**

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

1.15 **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 product information 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 Performance Verification: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from CxA after distinct phases have been completed and before commencing next phase.
- .4 Document required tests on approved performance verification forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by CxA . 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 CxA.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by CxA.
- .3 If evaluation report concludes that major damage has occurred, CxA shall reject equipment.
 - .1 Rejected equipment to be removed from site and replaced with new.
- .4 Subject new equipment/systems to specified start-up procedures.

1.16 **START-UP DOCUMENTATION**

- .1 Assemble start-up documentation and submit to 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 the contractor or CxA to repeat start-up at any time.

1.17 **OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS**

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit to CxA for approval before implementation.
- .3 Operate and maintain systems for minimum 21 days for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of Substantial Completion

1.18 **TEST RESULTS**

- .1 If start-up, testing and/or performance verification produce unacceptable results, repair, replace or repeat specified starting and/or performance verification procedures until acceptable results are achieved.
- .2 Provide personnel, resources and materials, assume all costs for re-verification.

1.19 **START OF COMMISSIONING**

- .1 Notify CxA 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.
- .3 Ensure all HVAC systems have been thoroughly cleaned.

1.20 INSTRUMENTS / EQUIPMENT

- .1 Submit to 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 all required equipment to complete commissioning.

1.21 FUNCTIONAL TEST & COMMISSIONING PERFORMANCE VERIFICATION

- .1 Conduct commissioning once identified pre-requisite activities are completed for a system and approved by the CxA.
- .2 CxA to issue a commissioning manual based on the complexity of building systems. Contractor to develop and implement a detailed schedule of commissioning related activities.
- .3 Test all building systems including architectural, structural, civil, mechanical and electrical components and operating procedures by challenging these systems to realistic operating conditions and train operational staff.
- .4 Run systems through all sequences of operation and verify response of components.
- .5 Notwithstanding all-inclusive requirements specified in this section, additional separate commissioning may be required at a later date for equipment and systems whose full operation is dependent on seasonal conditions. Job conditions for Peak Performance Verification are as follows: (1) Summer sequence commissioning to take place between June 1 and September 15 when outside ambient temperatures are at least 22°C; (2) Winter sequence commissioning to take place between November 1 and March 31 when outside ambient temperature is no greater than minus 10°C.
- .6 Carry out Cx:
 - .1 Under actual operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .7 Cx procedures to be repeatable and reported results are to be verifiable.
- .8 Follow equipment manufacturer's operating instructions.
- .9 EMCS trending to be available as supporting documentation for performance verification.

- .10 Contractor to obtain all documentation, including updated points list, controls sequences and setpoints, and submit documentation to commissioning authority for review. At completion of commissioning, scan completed manuals to electronic format on CD(s) in PDF format as required and submit to CxA.

1.22 WITNESSING COMMISSIONING

- .1 CxA along with designated representatives to witness activities and verify results.

1.23 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 CxA within 5 days of test and with Cx report.

1.24 REPEAT VERIFICATIONS

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

1.25 DEFICIENCIES, FAULTS, DEFECTS

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

1.26 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 application for Substantial Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Engineer/Architect.
- .4 Contractor to compile a Final Commissioning Report summarizing all tasks, findings and documentation of the commissioning process. The Final

Commissioning Report is to incorporate all test reports by sub-contractors, manufacturer's and controlling authorities including:

- .1 Evaluation of operating condition of the systems at the time of functional test completion.
- .2 Deficiencies that were discovered and measures taken to correct them.
- .3 Functional test procedures and results.
- .4 Documentation of all commissioning field activities as they progressed.
- .5 Description and estimated schedule of required deferred testing.

1.27 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.28 TRAINING

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

1.29 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.30 OCCUPANCY

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

1.31 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 5 % of specified values.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

1.32 OWNER'S PERFORMANCE TESTING

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

2 **PRODUCTS (NOT APPLICABLE)**

3 **EXECUTION**

3.1 **SCHEDULE**

- .1 Provide a detailed schedule for on-site verification activity by the commissioning team based on the commissioning plan provided by the CxA. Be responsible for resource allocation respecting the exact number and duration for personnel required to perform the tasks required.

3.2 **COMMISSIONING TASKS**

- .1 Refer to the Commissioning Manual provided by the CxA for a list of tasks to be conducted for the commissioning process. Further specifics are provided within applicable specification sections.

END OF SECTION