

Part 1 General

1.1 SUMMARY

- .1 ACRONYMS:
 - .1 Cx – Commissioning.
 - .2 EMCS – Energy Monitoring and Control Systems.
 - .3 O&M – Operation and Maintenance manual.
 - .4 PI – Product Information.
 - .5 PV – Performance Verification.
 - .6 TAB – Testing, Adjusting and Balancing.

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 system and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.
- .2 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 O&M manual.
 - .3 Effectively train O&M staff.
- .3 Contractor assists in Cx process, operating equipment and systems, trouble-shooting 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 interactive with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .4 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

- .1 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .2 Cx responsibilities are to ensure the built system 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.

.3 Consultant will issue Interim Acceptance Certificate when:

- .1 Completed Cx documentation has been received, reviewed for suitability and approved by Commissioning manager.
- .2 Equipment, components and systems have been commissioned.
- .3 O&M Manual received, reviewed and approved.
- .4 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 unfunctional system, including related systems as deemed required by consultant, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-Cx REVIEW

.1 Before Construction:

- .1 Review contract documents, confirm by writing to consultant.
 - .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 Ensure installation of related components, equipment, sub-systems, and systems are complete.
- .2 Fully understand Cx requirements and procedures.
- .3 Have Cx documentation shelf ready.
- .4 Understand completely design criteria and intent and special features.
- .5 Submit complete start-up documentation to Commissioning manager and Consultant.
- .6 Have Cx schedules up-to-date.

- .7 Ensure systems have been cleaned thoroughly.
 - .8 Complete TAB procedures on systems; submit TAB reports to consultant for review and approval.
 - .9 Ensure “As-Built” system schematics are available.
- .4 Inform consultant in writing of discrepancies and deficiencies on finished works.
- 1.6 **CONFLICTS**
 - .1 Report conflicts between requirements of this section and other sections to consultant before start-up and obtain clarification.
 - .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.
- 1.7 **SUBMITTALS**
 - .1 Submittals: in accordance with Section 01 33 00 Submittal Procedures.
 - .1 Submit no later than 4 weeks after award of Contract:
 - .1 Name of Contractor’s Cx agent.
 - .2 Draft Cx documentation.
 - .3 Preliminary Cx schedule.
 - .2 Request in writing to consultant for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to consultant where 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 Commissioning manager.
- 1.8 **COMMISSIONING DOCUMENTATION**
 - .1 Refer to Section 01 91 33 – Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and Instructions for use.
 - .2 Consultant to review and approve Cx documentation.
 - .3 Provide completed and approved Cx documentation to consultant and Cx Manager.
- 1.9 **COMMISSIONING SCHEDULE**
 - .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.07 – Construction Progress Schedules – Bar (GANTT) Chart.
 - .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.

1.10 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following project meeting: Section 01 32 16.07 – Construction Progress Schedules – Bar (GANTT) Chart 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 16.07 – Construction Progress Schedules – Bar (GANTT) Chart. Consultant 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 consultant, who will record and distribute minutes.
- .7 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 with 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 Commissioning manager to witness of start-up and testing.
- .3 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 consultant.
 - .3 Arrange for Commissioning manager to witness tests.
 - .4 Obtain written approval of test results and documentation from consultant 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 consultant.
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer's 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 deliver and installation:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.

- .4 System PV: include repetition of tests after correcting deficiencies.
- .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from consultant after distinct phases have been completed and before commencing next phase.
- .4 Document required tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by consultant. 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 consultant.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by consultant.
 - .3 If evaluation report concludes that major damage has occurred, consultant 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 consultant 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 Commissioning manager 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 consultant 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 PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
 - .2 Provide starting manpower and materials, assume costs for re-commissioning.
- 1.18 START OF COMMISSIONING
 - .1 Notify consultant and commissioning manager at least 14 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 consultant 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 [actual] [accepted simulated] operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
 - .2 Cx procedures to be repeatable and reported results are to be verifiable.
 - .3 Follow equipment manufacturer's operating instructions.
 - .4 EMCS trending to be available as supporting documentation for performance verification.
- 1.21 WITNESSING COMMISSIONING
 - .1 Commissioning manager to witness activities and verify results.
 - .2 Engineer to certify all PV results.

- .3 Contractors to be present at all tests.
- 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 consultant within 5 days of test and with Cx report.
- 1.23 EXTENT OF VERIFICATION
 - .1 Elsewhere:
 - .1 Provide manpower and instrumentation to verify all reported results, unless specified otherwise in other sections.
 - .2 Number and location to be at discretion of consultant.
 - .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
 - .4 Perform additional commissioning until results are acceptable to consultant.
- 1.24 REPEAT VERIFICATIONS
 - .1 Assume costs incurred by consultant for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Consultant's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Consultant deems Contractor's request for second verification was premature.
- 1.25 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.
- 1.26 DEFICIENCIES, FAULTS, DEFECTS
 - .1 Correct deficiencies found during start-up and Cx to satisfaction of consultant.
 - .2 Report problems, faults or defects affecting Cx to consultant in writing. Stop Cx until problems are rectified. Proceed with written approval from consultant.
- 1.27 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 consultant.

1.28 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.29 TRAINING

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

1.30 MAINTENANCE MATERIALS, SPARE PART, SPECIAL TOOLS

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

1.31 OCCUPANCY

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

1.32 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited with Commissioning manager.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.33 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria.
- .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.

1.34 OWNER'S PERFORMANCE TESTING

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

Part 2 **Products**

2.1 NOT USED

Part 3 **Execution**

3.1 NOT USED

END OF SECTION