

PART I – GENERAL**RELATED DOCUMENTS**

- Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section. Requirements of this section DO NOT release the Contractor from compliance with requirements of individual specification sections.
- OPR and BoD documentation prepared by Owner and Architect contains requirements that apply to this Section.

SUMMARY

- This Section includes general requirements that apply to implementation of commissioning for ALL systems to be commissioned. Contractor should refer all disciplines to this section.
- Related work includes the following:
 1. Division 15 Mechanical.
 2. Division 16 Electrical.

DEFINITIONS

- BoD: Basis of Design, also referred to as the Design Intent Document.
- CxA: Commissioning Authority.
- OPR: Owner's Project Requirements.
- Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
- TAB: Testing, Adjusting, and Balancing.

COMMISSIONING TEAM

- Members Appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of sub-Contractors associated with each of the applicable divisions, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- Members Appointed by Owner:
 1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
 2. Representatives of the facility user and operation and maintenance personnel.
 3. Architect and engineering design professionals.

OWNER'S RESPONSIBILITIES

- Provide the OPR documentation to the CxA and Contractor for use in developing the commissioning plan and testing plans and checklists.
- Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
 1. Coordination meetings.
 2. Testing meetings.
 3. Demonstration of operation of systems, subsystems, and equipment.
 4. Training in operation and maintenance of systems, subsystems, and equipment.
- Provide utility services required for the commissioning process.
- Provide the BoD documents, prepared by Architect/Engineer and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan, and testing plans and checklists.

CONTRACTOR'S RESPONSIBILITIES

- Provide utility services required for the commissioning process.
- Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 1. Participate in design- and construction-phase coordination meetings.
 2. Distribute (CxA provided) pre-functional checklists to appropriate subcontractors.
 3. Ensure completion of, and collect, completed Pre-functional checklists and return to CxA.
 4. Participate in Pre-Functional and Functional Testing meetings.
 5. Participate in maintenance orientation and inspection.
 6. Participate in operation and maintenance training sessions.
 7. Participate in final review at acceptance meeting.
 8. Certify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
 9. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend and coordinate corrective action.
 10. Review and approve final commissioning documentation.

- Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
- Related work includes the following:
 1. Participate in design and construction phase coordination meetings.
 2. Participate in procedures meeting for testing.
 3. Provide information to the CxA for developing construction phase commissioning plan.
 4. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
 5. Provide updated Project Record Documents to the CxA on a weekly basis.
 6. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures and participate in testing of installed systems, subsystems, and equipment. Ensure participation of equipment/system vendors as required.
 7. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA, as specified in Division 01 Section "Operation and Maintenance Data."
 8. Complete Pre-functional Checklists Provided by CxA as distributed by the Contractor, and return *prior* to functional performance testing.
 9. Participate in maintenance orientation and inspection.
 10. Prepare Training Manuals and participate in training sessions for Owner's operation and maintenance personnel.
 11. Participate in final review at acceptance meeting.

commissioning activities coordinated with overall Project schedule. Identify commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.

- Review and comment on submittals from Contractor and sub-Contractor for compliance with the OPR, BoD, Contract Documents, and construction-phase commissioning plan. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the OPR and BoD.
- Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The CxA shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.
- At the beginning of the construction phase, conduct an initial construction-phase coordination meeting for the purpose of reviewing the commissioning activities and establishing preliminary schedules for pre-functional testing, functional testing, operation and maintenance submittals; operation and maintenance training sessions; TAB Work; and Project completion.
- Prepare Project-specific pre-functional checklists to be used by Contractor and sub-Contractors.
- Schedule, direct, witness, and document functional performance testing.
- Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.
- Provide blank functional performance testing forms for inclusion in operations and maintenance manuals to facilitate future recommissioning efforts.
- Certify date of acceptance and startup for each item of equipment for start of warranty periods.
- Review Project Record Documents for accuracy. Request revisions from Contractor to achieve accuracy. Project Record Documents requirements are specified in Division 01 Section "Project Record Documents."
- Review and comment on operation and maintenance documentation and systems manual outline for compliance with the OPR, BoD, and Contract Documents. Operation and maintenance documentation requirements are specified in Division 01 Section "Operation and Maintenance Data."
- Review operation and maintenance training program outline and coordinate participation by sub-Contractors and equipment vendors to provide qualified instructors to conduct operation and maintenance training.
- Prepare commissioning reports.

CXA'S RESPONSIBILITIES

- Organize and lead the commissioning team.
- Prepare a construction-phase commissioning plan. Collaborate with Contractor and with subcontractors to develop commissioning checklists that will be used by (sub) Contractors to prepare detailed test and inspection procedures. Include design changes and scheduled

- Assemble the final commissioning documentation, including the commissioning report and Project Record Documents.
- Participate in a 10 month review of building's operations and maintenance and develop a plan for resolving outstanding commissioning related issues.

COMMISSIONING DOCUMENTATION

- Index of Commissioning Documents: CxA shall prepare an index to include storage location of each document.
- OPR: A written document, prepared by Owner, that details the functional requirements of Project and expectations of how it will be used and operated. This document includes Project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information.
- BoD Document: A document, prepared by Architect and MEP Engineer, that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- Commissioning Plan: A document, prepared by CxA, that outlines the documentation requirements of the commissioning process, and shall include, but is not limited to the following:
 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
 2. Identification of systems and equipment to be commissioned.
 3. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
 4. Identification of items that must be completed before the next operation can proceed.
 5. Description of responsibilities of commissioning team members.
 6. Description of observations to be made.
 7. Description of requirements for operation and maintenance training, including required training materials.
 8. Description of expected performance for systems, subsystems, equipment, and controls.
 9. Schedule for commissioning activities with specific dates coordinated with overall construction schedule.

10. Identification of installed systems, subsystems, and equipment, including design changes that occurred during the construction phase.
 11. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
 12. Process and schedule for completing pre-functional checklists and functional performance tests for systems, subsystems, and equipment to be verified and tested.
 13. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.
- Pre-functional Checklists: CxA, with assistance of project manager, mechanical engineer, and controls contractor shall develop pre-functional checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Prepare separate functional performance tests for each mode of operation and provide space to indicate whether the mode under test responded as required. Provide space for testing personnel to sign off on each checklist. Each checklist, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:
 1. Name and identification code of tested item.
 2. Test number.
 3. Time and date of test.
 4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
 5. Dated signatures of the person performing test and of the witness, if applicable.
 6. Individuals present for test.
 7. Deficiencies.
 8. Issue number, if any, generated as the result of test.
 - Test and Inspection Reports: CxA shall record test data, observations, and measurements on test checklists. Photographs, forms, and other means appropriate for the application shall be included with data. CxA shall compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.
 - Corrective Action Documents: CxA shall document corrective action taken for systems and equipment that fail tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results.
 - Issues Log: CxA shall prepare and maintain an issues log that describes design, installation, and performance issues that are at

variance with the OPR, BoD, and Contract Documents. Identify and track issues as they are encountered, documenting the status of unresolved and resolved issues.

1. Creating an Issues Log Entry:
 - a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
 - b. Assign a descriptive title of the issue.
 - c. Identify date and time of the issue.
 - d. Identify test number of test being performed at the time of the observation, if applicable, for cross-reference.
 - e. Identify system, subsystem, and equipment to which the issue applies.
 - f. Identify location of system, subsystem, and equipment.
 - g. Include information that may be helpful in diagnosing or evaluating the issue.
 - h. Note recommended corrective action.
 - i. Identify commissioning team member responsible for corrective action.
 - j. Identify expected date of correction.
 - k. Identify person documenting the issue.
2. Documenting Issue Resolution:
 - a. Log date correction is completed or the issue is resolved.
 - b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
 - c. Identify changes to the OPR, BoD, or Contract Documents that may require action.
 - d. State that correction was completed and system, subsystem, and equipment are ready for retest, if applicable.
 - e. Identify person(s) who corrected or resolved the issue.
 - f. Identify person(s) documenting the issue resolution.
3. Issues Log Report: On a periodic basis, but not less than for each commissioning team meeting, CxA shall prepare a written narrative for review of outstanding issues and a status update of the issues log. As a minimum, CxA shall include the following information in the issues log and expand it in the narrative:
 - a. Issue number and title.
 - b. Date of the identification of the issue.
 - c. Name of the commissioning team member assigned responsibility for resolution.
 - d. Expected date of correction.

- Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the OPR, BoD, and Contract Documents. The commissioning report shall include, but is not limited to, the following:
 1. Lists and explanations of substitutions; compromises; variances in the OPR, BoD, and Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. This report shall be used to evaluate systems, subsystems, and equipment and shall serve as a future reference document during Owner occupancy and operation. It shall describe components and performance that exceed requirements of the OPR, BoD, and Contract Documents and those that do not meet requirements of the OPR, BoD, and Contract Documents. It may also include a recommendation for accepting or rejecting systems, subsystems, and equipment.
 2. OPR and BoD documentation.
 3. Commissioning plan.
 4. Testing plans and reports.
 5. Corrective modification documentation.
 6. Issues log.
 7. Completed test checklists.
 8. Listing of off-season test(s) not performed and a schedule for their completion.

SUBMITTALS

- Commissioning Plan Prefinal Submittal: CxA shall submit hard copies of prefinal commissioning plan. Deliver one copy to Contractor, Owner, Engineer and Architect. Present submittal in sufficient detail to evaluate data collection and arrangement process. One copy, with review comments, will be returned to the CxA for preparation of the final construction-phase commissioning plan.
- Commissioning Plan Final Submittal: CxA shall submit hard and digital copies of final commissioning plan. The final submittal must address previous review comments. The final submittal shall include a copy of the prefinal submittal review comments along with a response to each item.
- Pre-functional Checklists: CxA shall submit pre-functional checklists to Contractor to distribute to sub-contractors for completion. These checklists shall be completed by the installing sub-contractors.
- Test and Inspection "Trip" Reports: CxA shall submit test and inspection reports.

- Corrective Action Documents: CxA shall submit corrective action documents.
- Prefinal Commissioning Report Submittal: CxA shall submit hard copies of the prefinal commissioning report. Include a copy of the preliminary submittal review comments along with CxA's response to each item. CxA shall deliver one copy to Owner and one copy to Architect. One copy, with review comments, will be returned to the CxA for preparation of final submittal.
- Final Commissioning Report Submittal: CxA shall submit hard copies and electronically formatted information of the final commissioning report. CxA shall deliver one hard copy and one set of discs to Owner, and one copy to Architect. The final submittal must address previous review comments and shall include a copy of the prefinal submittal review comments along with a response to each item.

QUALITY ASSURANCE

- Instructor Qualifications: Factory-authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

COORDINATION

- Coordination Meetings: CxA shall conduct coordination meetings of the commissioning team to review progress on the commissioning plan, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities. Frequency of meetings shall vary depending on phase of construction, but at least once monthly and not more than once weekly.
- Pretesting Meetings: CxA shall conduct pretest meetings of the commissioning team to review startup reports, pre-functional checklist results, testing procedures, testing personnel and instrumentation requirements, and manufacturers' authorized service representative services for each system, subsystem, equipment, and component to be tested. Separate Pretesting meetings shall be held with each subcontractor responsible for each subsystem to be tested. Pretesting meetings shall take place prior to Functional Performance Testing and can occur via conference call.
- Testing Coordination: CxA shall coordinate sequence of testing activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

- Manufacturers' Field Services: CxA shall coordinate through Contractor and sub-Contractors for manufacturers' field services.

PART II – PRODUCTS

(NOT USED)

Part III – Execution

GENERAL

- A commissioning team scoping meeting shall be held at a time and place designated by CxA within 14 days of issuance of Notice to Proceed. Owner, Commissioning Authority, General Contractor, and all major sub-Contractors (Mechanical, Electrical, and Controls) shall be present at this meeting. The purpose of the meeting is to review the preliminary Construction Phase Commissioning Plan, familiarize all parties with the requirements of the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- Separate meetings including individual equipment suppliers and subcontractors shall be held prior to commissioning of their systems as outlined in Part-1 of this Section.
- CxA shall update and modify the Commissioning Plan as needed after meeting with Contractor and sub-Contractors to reflect updated scope and schedule.
- Contractor shall include in proposal the time required to attend and have suppliers and subcontractors attend Commissioning Meetings associated with each item scheduled to be commissioned under Part 4 of this specification.

SUBMITTAL REVIEW

- CxA shall review submittals for systems listed in Part-4 of this specification to obtain information needed to fine-tune Pre-Functional and Functional Checklists based on actual equipment and systems to be installed.
- Should CxA discover discrepancies between submitted data and design requirements, he shall issue submittal review comments to Architect, Engineer, and Owner.
- Upon approval of submittals, Contractor and sub-Contractors shall submit preliminary Operations and Maintenance manuals for systems listed in Part-4 of this specification for review by Owner, Architect and CxA.
- Upon review of comments issued on preliminary O&M Manuals, Contractor and sub-Contractors shall issue final O&M Manuals for use by CxA in preparing testing checklists and training manuals.

INSPECTION AND TESTING

- CxA shall prepare pre-functional checklists and functional performance tests for all systems to be commissioned as listed in Part 4 of this specification.
- Contractor and sub-Contractors shall complete and sign all pre-functional checklists prior to system startup of the equipment/system they have installed. Completed pre-functional checklists shall then be submitted to the CxA via the General Contractor.
- Upon completion and CxA approval of pre-functional checklists, functional performance testing shall begin. CxA shall coordinate with Contractor and individual sub-Contractors to schedule execution of functional performance testing. Contractor and sub-Contractors shall perform functional performance tests in the presence of CxA. There are two distinct types of tests for which the Contractor is responsible:
 1. Pre-Functional Checklists: These tests ensure that all equipment and systems are installed in accordance with specifications, drawings, manufacturer's requirements, and all applicable codes, and are started-up according to manufacturer's instructions. The CxA need not witness these tests.
 2. Functional Performance Tests: These tests ensure that all the equipment and systems can operate in accordance with design intent in all modes of operation. Functional performance tests shall be developed by the CxA for each system individually and for the system as a whole once all controls are implemented. Tests not witnessed by CxA shall not be considered complete
- Contractor and sub-Contractor shall make all test readings available to CxA and shall initial checklists prepared by CxA noting whether or not test requirements have been met.
- CxA shall issue test reports with readings and checklists and a listing of any deficiencies that must be addressed by Contractor or sub-Contractors.
- Contractor and sub-Contractors shall in proposal include all costs associated with preparation and execution of Testing Procedures for all items listed in Part 4 of this specification.

OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- Training Manuals: Operations and Maintenance (O&M) manuals for each piece of equipment will be prepared by the installing sub-contractors. The CxA will collaborate with the Start-up and Testing Contractor (Entek, Inc.) to develop a systems manual that provides future operating staff the information needed to understand and optimally operate the integrated commissioned systems listed in Part-4 of this Section.

- Training Materials: Contractor and sub-Contractors shall provide documentation and materials required for training for each specific system or subsystem. CxA shall assemble into comprehensive training manual for each system or subsystem.
- Training: The CxA will verify that the requirements for training operating personnel and building occupants have been completed.
- Instructors: The Contractor shall act as coordinator of training activities. Contractor and sub-Contractors shall make available competent technicians and/or equipment representatives to conduct specialized aspects of systems and subsystems training under the direction of CxA.
- Training Sessions: The Contractor shall schedule Training Sessions after successful completion of Functional Performance Testing for individual systems, as listed in Part-4 of this specification. Contractor shall set aside no less than four (4) hours of training for each item to be commissioned.

COMMISSIONING REPORT

- Upon successful completion of testing procedures, and operation and maintenance training requirements, CxA shall prepare preliminary and final Commissioning Reports as detailed elsewhere in this specification.
- Contractor and sub-Contractors shall provide the following documentation for inclusion as part of the Commissioning Report:
 1. Record/As-built drawings and documentation.
 2. Final Operations and Maintenance Manuals.

Part IV – Systems to be Commissioned**GENERAL**

- The following outline of commissioning requirements by Division is provided as a guideline for Contractor, sub-Contractors, and CxA to understand the nature and extent of commissioning work, so that resources may be properly allocated.
- Commissioning specifications supplement requirements of individual specifications sections, but shall not be interpreted to replace or diminish the specified scope of any individual section.
- Additional Commissioning requirements are included in Section 15995, and Section 16995.
- Contractor shall coordinate with sub-Contractors and equipment vendors/representatives to set aside adequate time to address Pre-Functional Checklists, Functional Performance Testing, Operations and Maintenance Training, and associated coordination meetings.
- CxA shall also conduct site inspections at critical times (generally only for functional performance testing) and issue Cx Field Reports with observations on installation deficiencies so that they may be issued by Architect as deemed appropriate.

- For all systems listed below, Contractor and sub-Contractors shall comply with all commissioning requirements specified, including:
 1. Full set of Submittals to CxA for preparation of checklists and training manuals. Provide drawings approved by Authority having jurisdiction.
 2. Submit Operations and Maintenance Data to CxA for preparation of checklists and training manuals.
 3. Complete Pre-functional (installation) Checklists, Functional Performance Testing Procedures and conduct inspections and testing. Ensure participation by certified installer during inspection and testing.
 4. Conduct Operations and Maintenance training with participation by certified installer.
 5. As-built drawings and documentation.
 6. Additional requirements specified in Commissioning Sections 15995 and 16995.
 7. Requirements of individual specification sections.
- The following systems (with the corresponding specifications section in parenthesis) shall further comply with the commissioning requirements for Training:
 1. Rooftop Units
 2. Energy Management Systems
 3. Energy Management Systems (Section 16210)
 4. Lighting (Section 16500)

END OF SECTION**APPLICABLE SYSTEMS TO COMMISSION**

- The following systems (with the corresponding specifications section in parenthesis) shall comply with the commissioning requirements for Submittals and Pre-Functional Testing:
 1. Piping Insulation (Section 15090)
 2. Plumbing – Dom. HW only (Section 15400)
 3. Rooftop Units
 4. Air Distribution Systems and Accessories – Submittals required; Pre-Functional testing by field observation only (Section 15810)
 5. Energy Management Systems
 6. Testing, Adjusting, and Balancing (Section 15990)
 7. Energy Management Systems (Section 16210)
 8. Lighting (Section 16500)
- The following systems (with the corresponding specifications section in parenthesis) shall also comply with the commissioning requirements for Functional Testing:
 1. Plumbing – Dom. HW only (Section 15400)
 2. Rooftop Units
 3. Energy Management Systems
 4. Testing, Adjusting, and Balancing (Section 15990)
 5. Energy Management Systems (Section 16210)
 6. Lighting (Section 16500)

This Page Intentionally Left Blank.