



**WMU Design Guidelines Instructions:** These guidelines are to be used by the Design Professional to inform the design process and outline WMU-specific desires for University projects. Text appearing in blue indicates a WMU design guideline which must be met for all campus projects unless approved in writing by the University. Blue text that is struck out indicates products or practices that are **not** acceptable, and shall not be included unless similarly approved. Any text remaining in black is to be edited by the Design Professional as part of the normal specifications-writing process. Guidelines language shall be included in the project specifications and their intent incorporated into the drawings.

## SECTION 01 9113 - GENERAL COMMISSIONING REQUIREMENTS

**Designer Note:** The Design Professional shall work with the Commissioning Authority to edit this section.

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. General requirements for coordinating and scheduling commissioning activities.
2. Commissioning meetings.
3. Commissioning reports.
4. Use of commissioning process test equipment, instrumentation, and tools.
5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
6. Commissioning tests and commissioning test demonstration.
7. Adjusting, verifying, and documenting identified systems and assemblies.

- B. Western Michigan University has retained the services of **[Commissioning Authority]** to serve as the project Commissioning Authority (CxA). **[Commissioning Authority]** will perform the items specified under Commissioning Authority responsibilities.

**Designer Note:** Regardless of whether the project is pursuing LEED certification, WMU projects shall follow the LEED guidelines with regard to commissioning activities.

- C. Green Building Design and Construction; LEED Reference Guide for Green Building Design and Construction, published by the U.S. Green Building Council.

1. Fundamental Commissioning and Verification.
2. Enhanced Commissioning.
  - a. Monitoring-based Commissioning.

#### 1.2 ALLOWANCES

- A. Labor and management costs for the performance of commissioning process.



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- B. The following are excluded from the commissioning allowance:
1. Equipment and systems installation, startup, and field quality-control testing indicated in the Contract Documents.
  2. Test equipment, instrumentation, and tools (including, but not limited to, proprietary test equipment, instrumentation, and tools) required to perform tests.
  3. Work to correct commissioning issues.
  4. Work to repeat tests when equipment and systems fail acceptance criteria.
  5. **<Insert requirements>**.

### 1.3 UNIT PRICES

- A. Commissioning allowance may be adjusted up or down by the "List of Unit Prices" Article in Section 01 2200 "Unit Prices" when actual labor hours are computed at the end of commissioning process. See Section 01 2100 "Allowances" for commissioning allowance.
- B. The following are excluded from the computation for the adjustment of the commissioning allowance for technician labor hours:
1. Work to correct commissioning issues.
  2. Work to repeat tests when equipment and systems fail acceptance criteria.

### 1.4 DEFINITIONS

- A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- B. Basis-of-Design Document: A document prepared by Architect that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.
- C. Commissioning Authority: An entity engaged by Owner, and identified in Section 01 1000 "Summary," to evaluate Commissioning-Process Work.
- D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.
- E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with Owner's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities. The scope of the commissioning process is defined in **[Section 01 1000 "Summary. "] [Section 01 1200 "Multiple Contract Summary. "]**
- F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished. Owner will establish in writing the date construction-phase



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commissioning-process completion is achieved. See Section 01 7700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.

1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:
  - a. Completion of tests and acceptance of test results.
  - b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
  - c. Comply with requirements in Section 01 7900 "Demonstration and Training."
  - d. Completion and acceptance of submittals and reports.
- G. Owner's Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Owner or for the Owner by the Architect or Commissioning Authority.
- H. Owner's Witness: Commissioning Authority, Owner's Project Manager, or Architect-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.
- I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- K. Sampling Procedures and Tables for Inspection by Attributes: As defined in ASQ Z1.4.

### 1.5 ABBREVIATIONS

- A. The following industry standard abbreviations are used by WMU and their Commissioning Authority:
  1. A/E: Architect/Engineer
  2. AOR: Architect of Record
  3. BOD: Basis of Design
  4. CM: Construction Manager
  5. CxA: Commissioning Authority
  6. Cx: Commissioning
  7. EOR: Engineer of Record
  8. FPT: Functional Performance Test
  9. FTS: Functional (Performance) Test Script
  10. GC: General Contractor
  11. O&M: Operations and Maintenance
  12. OPR: Owner's Project Requirements
  13. PFC: Pre-Functional Checklist
  14. SOR: Site Observation Report
  15. TAB: Testing, Adjusting, and Balancing
  16. TS: Technical Specifications



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### 1.6 COMPENSATION

- A. If Architect, Commissioning Authority, other Owner's witness, or Owner's staff perform additional services or incur additional expenses due to actions of Contractor listed below, compensate Owner for such additional services and expenses.
1. Failure to provide timely notice of commissioning activities schedule changes.
  2. Failure to meet acceptance criteria for test demonstrations.
- B. Contractor shall compensate Owner for such additional services and expenses at the rate of **<Insert billing rate>** per labor hour, plus **<Insert rate>** per round trip for personnel travelling more than **[200] <Insert distance>** miles, plus per diem allowances for meals and lodging according to current U.S. General Services Administration (GSA) Per Diem Rates.

### 1.7 COMMISSIONING TEAM

A. Members Appointed by Contractor(s):

1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.
3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a particular portion of the commissioning process. **Appropriate entities may include, but are not limited to, representatives of the following:**
  - a. Fire suppression.
  - b. Plumbing.
  - c. HVAC sheet metal.
  - d. HVAC piping.
  - e. Test and balance.
  - f. Direct digital controls.
  - g. Electrical.
  - h. Fire alarm.
  - i. Refrigeration.
  - j. Food service.
4. Appointed team members shall have the authority to act on behalf of the entity they represent.

B. Members Appointed by Owner:

1. Commissioning Authority, plus consultants that Commissioning Authority may deem appropriate for a particular portion of the commissioning process.
2. Owner representative(s), facility operations and maintenance personnel, plus other employees, separate contractors, and consultants that Owner may deem appropriate for a particular portion of the commissioning process.
3. Architect, plus employees and consultants that Architect may deem appropriate for a particular portion of the commissioning process.
4. **[Construction Manager][General Contractor]**, plus employees and subcontractors that the **[Construction Manager][General Contractor]** may deem appropriate for a particular portion of the commissioning process.



## 1.8 INFORMATIONAL SUBMITTALS

- A. Comply with requirements in Section 01 3300 "Submittal Procedures" for submittal procedure general requirements for commissioning process.
- B. Commissioning Plan Information:
  - 1. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors performing the various commissioning requirements.
  - 2. Schedule of commissioning activities, integrated with the Construction Schedule. Comply with requirements in Section 01 3200 "Construction Progress Documentation" for the Construction Schedule general requirements for commissioning process.
  - 3. Contractor personnel and subcontractors participating in each test.
  - 4. List of instrumentation required for each test to include identification of parties that will provide instrumentation for each test.
- C. Commissioning schedule.
- D. Two-week look-ahead schedules.
- E. Commissioning Coordinator Letter of Authority:
  - 1. Within 10 days after approval of Commissioning Coordinator qualifications, submit a letter of authority for Commissioning Coordinator, signed by a principal of Contractor's firm. Letter shall authorize Commissioning Coordinator to do the following:
    - a. Make inspections required for commissioning process.
    - b. Coordinate, schedule, and manage commissioning process of Contractor, subcontractors, and suppliers.
    - c. Obtain documentation required for commissioning process from Contractor, subcontractors, and suppliers.
    - d. Report issues, delayed resolution of issues, schedule conflicts, and lack of cooperation or expertise on the part of members of the commissioning team.
- F. Commissioning Coordinator Qualification Data: For entity coordinating Contractor's commissioning activities to demonstrate their capabilities and experience.
  - 1. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of **[five]** **<Insert number>** previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- G. List test instrumentation, equipment, and monitoring devices. Include the following information:
  - 1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
  - 2. Brief description of intended use.
  - 3. Calibration record showing the following:
    - a. Calibration agency, including name and contact information.
    - b. Last date of calibration.
    - c. Range of values for which calibration is valid.
    - d. Certification of accuracy.



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- e. Certification for calibration equipment traceable to NIST.
- f. Due date of the next calibration.

### H. Test Reports:

- 1. Pre-Startup Report: Prior to startup of equipment or a system, submit signed, completed construction checklists.
- 2. Test Data Reports: At the end of each day in which tests are conducted, submit test data for tests performed.
- 3. Commissioning Issue Reports: Daily, at the end of each day in which tests are conducted, submit commissioning issue reports for tests for which acceptable results were not achieved.
- 4. Weekly Progress Report: Weekly, at the end of each week in which tests are conducted, submit a progress report.
- 5. Data Trend Logs: Submit data trend logs at the end of the trend log period.
- 6. System Alarm Logs: Daily, at the start of days following a day in which tests were performed, submit printout of log of alarms that occurred since the last log was printed.

### I. Construction Checklists:

- 1. Material checks.
- 2. Installation checks.
- 3. Startup procedures, where required.

## 1.9 CLOSEOUT SUBMITTALS

### A. Commissioning Report:

- 1. At Construction-Phase Commissioning Completion, include the following:
  - a. Pre-startup reports.
  - b. Approved test procedures.
  - c. Test data forms, completed and signed.
  - d. Progress reports.
  - e. Commissioning issue report log.
  - f. Commissioning issue reports showing resolution of issues.
  - g. Correspondence or other documents related to resolution of issues.
  - h. Other reports required by commissioning process.
  - i. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
  - j. Report shall include commissioning work of Contractor.

### B. Request for Certificate of Construction-Phase Commissioning Process Completion.

### C. Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

## 1.10 QUALITY ASSURANCE

### A. [ASHRAE Guidelines: The latest version of ASHRAE Guideline 1.1 and ASHRAE Guideline 0.](#)



- B. Commissioning Coordinator Qualifications:
  - 1. Documented experience commissioning systems of similar complexity to those contained in these documents on at least [three] <Insert number> projects of similar scope and complexity.
  - 2. Certification of commissioning-process expertise. The following certifications are acceptable. Owner reserves the right to accept or reject certifications as evidence of qualification.
    - a. Certified Commissioning Authority, by AABC Commissioning Group (ACG).
    - b. Commissioning-Process Management Professional or Building Commissioning Professional, by American Society of Heating, Refrigerating and Air-Conditioning Engineers.
    - c. Certified Commissioning Professional, by Building Commissioning Association.
    - d. Accredited Commissioning-Process Authority Professional, by University of Wisconsin.
    - e. Accredited Commissioning-Process Manager, by University of Wisconsin.
    - f. Accredited Green Commissioning-Process Provider, by University of Wisconsin.
- C. Calibration Agency Qualifications: Certified by The American Association for Laboratory Accreditation that the calibration agency complies with minimum requirements of ISO/IEC 17025.
- D. Inter-National Testing Association: The latest version of NETA Acceptance Testing Specifications (ATS).
- E. Instructor Qualifications: Factory authorized service representatives, experienced in training, operation and maintenance procedures for installed systems, subsystems and equipment.

## PART 2 - PRODUCTS

### 2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Test equipment and instrumentation required to perform the commissioning process shall remain the property of Contractor unless otherwise indicated.
- B. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:
  - 1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
  - 2. Calibrated and certified.
    - a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever



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- is more frequent, but not less than within six months of initial use on Project. Calibration tags shall be permanently affixed.
  - b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.
  - c. If not otherwise noted, the following minimum requirements apply: temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards to an accuracy of 0.5 deg F and a resolution of plus or minus 0.1 deg F. Pressure sensors shall have an accuracy of plus or minus 2.0% of the value range being measured (not full range of the meter).
- 3. Maintain test equipment and instrumentation.
  - 4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

### 2.2 PROPRIETARY TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate, or perform work on its equipment.
  - 1. Identify proprietary test equipment, instrumentation, and tools required in the test equipment identification list submittal.
  - 2. Proprietary test equipment, instrumentation, and tools shall become the property of Owner at Substantial Completion.

### 2.3 REPORT FORMAT AND ORGANIZATION

- A. General Format and Organization:
  - 1. Bind report in three-ring binders.
  - 2. Label the front cover and spine of each binder with the report title, volume number, project name, Contractor's name, and date of report.
  - 3. Record report on compact disk.
  - 4. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.
- B. Commissioning Report:
  - 1. Include a table of contents and an index to each test.
  - 2. Include major tabs for each Specification Section.
  - 3. Include minor tabs for each test.
  - 4. Within each minor tab, include the following:
    - a. Test specification.
    - b. Pre-startup reports.
    - c. Approved test procedures.
    - d. Test data forms, completed and signed.
    - e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation





related to resolution of issues for each test repetition together within the minor tab, in reverse chronological order (most recent on top).

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Review preliminary construction checklists and preliminary test procedures and data forms.

### 3.2 CONSTRUCTION CHECKLISTS

- A. Construction checklists cannot modify or conflict with the Contract Documents.
- B. Create construction checklists based on actual systems and equipment to be included in Project.
- C. Material Checks: Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.
  - 1. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
  - 2. Included optional features.
  - 3. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.
  - 4. Installation Checks:
    - a. Location according to Drawings and approved Shop Drawings.
    - b. Configuration.
    - c. Compliance with manufacturers' written installation instructions.
    - d. Attachment to structure.
    - e. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
    - f. Utility connections are of the correct characteristics, as applicable.
    - g. Correct labeling and identification.
    - h. Startup Checks: Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.
- D. Startup: Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.
- E. Performance Tests:
  - 1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.



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2. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
  3. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
  4. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
  5. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.
- F. Deferred Construction Checklists: Obtain Owner approval of proposed deferral of construction checklists, including proposed schedule of completion of each deferred construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, deferred construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
1. Identify deferred construction checklists by number and title.
  2. Provide a target schedule for completion of deferred construction checklists.
  3. Written approval of proposed deferred construction checklists, including approved schedule of completion of each deferred construction checklist.
- G. Delayed Construction Checklists: Obtain Owner approval of proposed delayed construction checklists, including proposed schedule of completion of each delayed construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, delayed construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
1. Identify delayed construction checklist by construction checklist number and title.
  2. Provide a target schedule for completion of delayed construction checklists.
  3. Written approval of proposed delayed construction checklists, including approved schedule of completion of each delayed construction checklist.

### 3.3 GENERAL EXECUTION REQUIREMENTS

- A. Schedule and coordinate commissioning process with the Construction Schedule.
- B. Perform activities identified in construction checklists, including tests, and document results of actions as construction proceeds.
- C. Perform test demonstrations for Owner's witness. Unless otherwise indicated, demonstrate tests for 100 percent of work to which the test applies. In some instances, demonstration of a random sample of other than 100 percent of the results of a test is specified.
1. Where sampling is specified, the sampling plan and procedure for the test demonstration shall be determined using ASQ Z1.4.
    - a. General Inspection: [Level I] [Level II] [Level III] <Insert level>.
    - b. Special Inspection: [Level S-1] [Level S-2] [Level S-3] [Level S-4] <Insert level>.
    - c. Acceptance Quality Limit (AQL) of [1.5] <Insert AQL>.



2. The "lot size" in ASQ Z1.4 is the sum of the number of items to which the test demonstration applies, as described in the scope subparagraph of each test.
  3. On determination of the sample size, the samples shall be selected randomly by Owner's witness at the time of the test demonstration.
  4. Include in the Commissioning Plan a detailed list of the test demonstrations with lot and sample quantities for each test.
- D. Report test data and commissioning issue resolutions.
- E. Schedule personnel to participate in and perform Commissioning-Process Work.
- F. Installing contractors' commissioning responsibilities include, but are not limited to, the following:
1. Operating the equipment and systems they install during tests.
  2. In addition, installing contractors may be required to assist in tests of equipment and systems with which their work interfaces.

### 3.4 COMMISSIONING COORDINATOR RESPONSIBILITIES

- A. Management and Coordination: Manage, schedule, and coordinate commissioning process, including, but not limited to, the following:
1. Coordinate with subcontractors on their commissioning responsibilities and activities.
  2. Obtain, assemble, and submit commissioning documentation.
  3. **[Attend] [Conduct]** periodic on-site commissioning meetings. Comply with requirements in Section 01 3100 "Project Management and Coordination."
  4. Develop and maintain the commissioning schedule. Integrate commissioning schedule into the Construction Schedule. Update Construction Schedule at specified intervals.
  5. Review and comment on preliminary test procedures and data forms.
  6. Report inconsistencies and issues in system operations.
  7. Verify that tests have been completed and results comply with acceptance criteria, and that equipment and systems are ready before scheduling test demonstrations.
  8. Direct and coordinate test demonstrations.
  9. Coordinate witnessing of test demonstrations by Owner's witness.
  10. Coordinate and manage training. Be present during training sessions to direct video recording, present training, and direct the training presentations of others. Comply with requirements in Section 01 7900 "Demonstration and Training."
  11. Prepare and submit specified commissioning reports.
  12. Track commissioning issues until resolution and retesting is successfully completed.
  13. Retain original records of Commissioning-Process Work, organized as required for the commissioning report. Provide Owner's representative access to these records on request.
  14. Assemble and submit commissioning report.

### 3.5 COMMISSIONING TESTING

- A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.



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- B. Owner's witness will be present to witness commissioning work requiring the signature of an owner's witness, including, but not limited to, test demonstrations. Owner's project manager will coordinate attendance by Owner's witness with Contractor's published Commissioning Schedule. Owner's witness will provide no labor or materials in the commissioning work. The only function of Owner's witness will be to observe and comment on the progress and results of commissioning process.
  
- C. Construction Checklists:
  - 1. Complete construction checklists as Work is completed.
  - 2. Distribute construction checklists to installing contractors before they start work.
  - 3. Installers:
    - a. Verify installation using approved construction checklists as Work proceeds.
    - b. Complete and sign construction checklists **[daily] [weekly] <Insert frequency>** for work performed during the preceding **[day] [week] <Insert time period>**.
  - 4. Provide Commissioning Authority access to construction checklists.
  
- D. Installation Compliance Issues: Record as an installation compliance issue Work found to be incomplete, inaccessible, at variance with the Contract Documents, nonfunctional, or that does not comply with construction checklists. Record installation compliance issues on the construction checklist at the time they are identified. Record corrective action and how future Work should be modified before signing off the construction checklist.
  
- E. Pre-Startup Audit: Prior to executing startup procedures, review completed installation checks to determine readiness for startup and operation. Report conditions, which, if left uncorrected, adversely impact the ability of systems or equipment to operate satisfactorily or to comply with acceptance criteria. Prepare pre-startup report for each system.
  
- F. Test Procedures and Test Data Forms:
  - 1. Test procedures shall define the step-by-step procedures to be used to execute tests and test demonstrations.
  - 2. Test procedures shall be specific to the make, model, and application of the equipment and systems being tested.
  - 3. Completed test data forms are the official records of the test results.
  - 4. Commissioning Authority will provide to Contractor preliminary test procedures and test data forms for performance tests and commissioning tests after approval of Product Data, Shop Drawings, and preliminary operation and maintenance manual.
  - 5. Review preliminary test procedures and test data forms, and provide comments within 14 days of receipt from Commissioning Authority. Review shall address the following:
    - a. Equipment protection and warranty issues, including, but not limited to, manufacturers' installation and startup recommendations, and operation and maintenance instructions.
    - b. Applicability of the procedure to the specific software, equipment, and systems approved for installation.
  - 6. After Contractor has reviewed and commented on the preliminary test procedures and test data forms, Commissioning Authority will revise and reissue the approved revised test procedures and test data forms marked "Approved for Testing."



7. Use only approved test procedures and test data forms marked "Approved for Testing" to perform and document tests and test demonstrations.

G. Performance of Tests:

1. The sampling rate for tests is 100 percent. The sampling rate for test demonstrations is 100 percent unless otherwise indicated.
2. Perform and complete each step of the approved test procedures in the order listed.
3. Record data observed during performance of tests on approved data forms at the time of test performance and when the results are observed.
4. Record test results that are not within the range of acceptable results on commissioning issue report forms in addition to recording the results on approved test procedures and data forms according to the "Commissioning Compliance Issues" Paragraph in this Article.
5. On completion of a test, sign the completed test procedure and data form. Tests for which test procedures and data forms are incomplete, not signed, or which indicate performance that does not comply with acceptance criteria will be rejected. Tests for which test procedures and data forms are rejected shall be repeated and results resubmitted.

H. Performance of Test Demonstration:

1. Perform test demonstrations on a sample of tests after test data submittals are approved. The sampling rate for test demonstrations shall be **[100] <Insert number>** percent unless otherwise indicated in the individual test specification.
2. Notify Owner's witness at least **[three days] <Insert alternative time>** in advance of each test demonstration.
3. Perform and complete each step of the approved test procedures in the order listed.
4. Record data observed during performance of test demonstrations on approved data forms at the time of demonstration and when the results are observed.
5. Provide full access to Owner's witness to directly observe the performance of all aspects of system response during the test demonstration. On completion of a test demonstration, sign the completed data form and obtain signature of Owner's witness at the time of the test to authenticate the reported results.
6. Test demonstration data forms not signed by Contractor and Owner's witness at the time of the completion of the procedure will be rejected. Test demonstrations for which data forms are rejected shall be repeated and results shall be resubmitted.
  - a. Exception for Failure of Owner's Witness to Attend: Failure of Owner's witness to be present for agreed-on schedule of test demonstration shall not delay Contractor. If Owner's witness fails to attend a scheduled test, Contractor shall proceed with the scheduled test. On completion, Contractor shall sign the data form for Contractor and for Owner's witness, and shall note the absence of Owner's witness at the scheduled time and place.
7. False load test requirements are specified in related sections.
  - a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Architect's written approval.



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### I. Deferred Tests:

1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved, deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:
  - a. Identify deferred tests by number and title.
  - b. Provide a target schedule for completion of deferred tests.
2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Architect and Commissioning Authority at least [**three working days**] <Insert alternative time> (minimum) in advance of tests.
3. Where deferred tests are specified, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule deferred tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

### J. Delayed Tests:

1. Delayed Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed delayed tests. Obtain Owner approval of proposed delayed tests, including proposed schedule of completion of each delayed test, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. Include the following in the request for Certificate of Construction-Phase Commissioning Process Completion:
  - a. Identify delayed tests by test number and title.
  - b. Written approval of proposed delayed tests, including approved schedule of completion of delayed tests.
2. Schedule and coordinate delayed tests. Schedule delayed tests when conditions that caused the delay have been rectified. Notify Architect and Commissioning Authority at least [**three working days**] <Insert alternative time> (minimum) in advance of tests.
3. Where delayed tests are approved, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule delayed tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

### K. Commissioning Compliance Issues:

1. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
3. If a test demonstration fails, determine the cause of failure. Direct timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials, reimburse Owner for billed costs for the participation in the repeated demonstration.
4. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:



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- a. Complete a commissioning compliance issue report form promptly on discovery of test results that do not comply with acceptance criteria.
  - b. Submit commissioning compliance issue report form within **[24 hours]** <Insert **alternative time**> of the test.
  - c. Determine the cause of the failure.
  - d. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.
5. Commissioning Compliance Issue Report: Provide a commissioning compliance issue report for each issue. Do not report multiple issues on the same commissioning compliance issue report.
- a. Exception: If an entire class of devices is determined to exhibit the identical issue, they may be reported on a single commissioning compliance issue report. (For example, if all return-air damper actuators that are specified to fail to the open position are found to fail to the closed position, they may be reported on a single commissioning issue report. If a single commissioning issue report is used for multiple commissioning compliance issues, each device shall be identified in the report, and the total number of devices at issue shall be identified.
  - b. Complete and submit Part 1 of the commissioning compliance issue report immediately when the condition is observed.
  - c. Record the commissioning compliance issue report number and describe the deficient condition on the data form.
  - d. Resolve commissioning compliance issues promptly. Complete and submit Part 2 of the commissioning compliance issue report when issues are resolved.
6. Diagnose and correct failed test demonstrations as follows:
- a. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
  - b. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
  - c. Record the results of each step of the diagnostic procedure.
  - d. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
  - e. Determine and record corrective measures.
  - f. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.
7. Retest:
- a. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Obtain signature of Owner's witness on retest data forms. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Owner for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
  - b. For each repeated test demonstration, submit a new test data form, marked "Retest."
8. Do not correct commissioning compliance issues during test demonstrations.



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- a. Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed in less than [five] <Insert number> minutes. If corrections are made under this exception, note the deficient conditions on the test data form and issue a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

### 3.6 COMMISSIONING MEETINGS

- A. **[Schedule and conduct] [Commissioning Authority will schedule and conduct]** commissioning meetings. Comply with requirements in Section 01 3100 "Project Management and Coordination."

### 3.7 SEQUENCING

- A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:
  - 1. Construction Checklists:
    - a. Material checks.
    - b. Installation checks.
    - c. Startup, as appropriate. Some startup may depend on component performance. Such startup may follow component performance tests on which the startup depends.
    - d. Performance Tests:
      - 1) Static tests, as appropriate.
      - 2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
      - 3) Equipment and assembly performance tests.
      - 4) System performance tests.
      - 5) Intersystem performance tests.
  - 2. Commissioning tests.
- B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to construction checklists.
- C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Architect if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.
- D. Commence tests as soon as installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.





### 3.8 SCHEDULING

- A. Commence commissioning process as early in the construction period as possible.
- B. Commissioning Schedule: Integrate commissioning activities into Construction Schedule. See Section 01 3200 "Construction Progress Documentation."
  - 1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
  - 2. Schedule the start date and duration for the following commissioning activities:
    - a. Submittals.
    - b. Preliminary operation and maintenance manual submittals.
    - c. Installation checks.
    - d. Startup, where required.
    - e. Performance tests.
    - f. Performance test demonstrations.
    - g. Commissioning tests.
    - h. Commissioning test demonstrations.
  - 3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.
  - 4. Determine milestones and prerequisites for commissioning process. Show commissioning milestones, prerequisites, and dependencies in monthly updated critical-path-method construction schedule and short-interval schedule submittals.
- C. Two-Week Look-Ahead Commissioning Schedule:
  - 1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
  - 2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
  - 3. Use two-week look-ahead schedules to notify and coordinate participation of Owner's witnesses.
- D. Owner's Witness Coordination:
  - 1. Coordinate Owner's witness participation via Architect.
  - 2. Notify Architect of commissioning schedule changes at least **[two]** <Insert number> work days in advance for activities requiring the participation of Owner's witness.

### 3.9 COMMISSIONING REPORTS

- A. Test Reports:
  - 1. Pre-startup reports include observations of the conditions of installation, organized into the following sections:
    - a. Equipment Model Verification: Compare contract requirements, approved submittals, and provided equipment. Note inconsistencies.



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- b. Preinstallation Physical Condition Checks: Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.
  - c. Preinstallation Component Verification Checks: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
  - d. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
  - e. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Owner completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.
2. Test data reports include the following:
- a. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
  - b. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
  - c. Signatures of individuals performing and witnessing tests.
  - d. Data trend logs accumulated overnight from the previous day of testing.
3. Commissioning Compliance Issue Reports: Report as commissioning compliance issues results of tests and test demonstrations that do not comply with acceptance criteria. Report only one issue per commissioning compliance issue report. Use sequentially numbered facsimiles of commissioning compliance issue report form included in this Section, or other form approved by Owner. Distribute commissioning compliance issue reports to parties responsible for taking corrective action. Identify the following:
- a. Commissioning compliance issue report number. Assign unique, sequential numbers to individual commissioning compliance issue reports when they are created, to be used for tracking.
  - b. Action distribution list.
  - c. Report date.
  - d. Test number and description.
  - e. Equipment identification and location.
  - f. Briefly describe observations about the performance associated with failure to achieve acceptable results. Identify the cause of failure if apparent.
  - g. Diagnostic procedure or plan to determine the cause (include in initial submittal)
  - h. Diagnosis of fundamental cause of issues as specified below (include in resubmittal).
  - i. Fundamental cause of unacceptable performance as determined by diagnostic tests and activities.
  - j. When issues have been resolved, update and resubmit the commissioning issue report forms by completing Part 2. Identify resolution taken and the dates and initials of the persons making the entries.
  - k. Schedule for retesting.



4. Weekly progress reports include information for tests conducted since the preceding report and the following:
  - a. Completed data forms.
  - b. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
  - c. Activities scheduled but not conducted per schedule.
  - d. Commissioning compliance issue report log.
  - e. Schedule changes for remaining Commissioning-Process Work, if any.
5. Data trend logs shall be initiated and running prior to the time scheduled for the test demonstration.
  - a. Trend log data format shall be multiple data series graphs. Where multiple data series are trend logged concurrently, present the data on a common horizontal time axis. Individual data series may be presented on a segmented vertical axis to avoid interference of one data series with another, and to accommodate different axis scale values. Graphs shall be sufficiently clear to interpret data within the accuracy required by the acceptance criteria.
  - b. Attach to the data form printed trend log data collected during the test or test demonstration.
  - c. Record, print out, and attach to the data form operator activity during the time the trend log is running. During the time the trend log is running, operator intervention not directed by the test procedure invalidates the test results.
6. System Alarm Logs: Record and print out a log of alarms that occurred since the last log was printed. Evaluate alarms to determine if the previous day's work resulted in any conditions that are not considered "normal operation."
  - a. Conditions that are not considered "normal operation" shall be reported on a commissioning issue report attached to the alarm log. Resolve as necessary. The intent of this requirement is to discover control system points or sequences left in manual or disabled conditions, equipment left disconnected, set points left with abnormal values, or similar conditions that may have resulted from failure to fully restore systems to normal, automatic control after test completion.

### 3.10 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

- A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Owner agrees to accept separately, is complete, Contractor shall prepare and submit to Owner and Commissioning Authority through Architect a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to complete commissioning process.
- B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case,



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Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.

- C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Architect's and Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.
- D. When construction-phase commissioning process or designated portion is complete, Commissioning Authority will prepare a Certificate of Construction-Phase Commissioning Process Completion that shall establish the date of completion of construction-phase commissioning process. Certificate of Construction-Phase Commissioning Process Completion shall be submitted prior to requesting inspection for determining date of Substantial Completion.

### 3.11 OPERATION AND MAINTENANCE MANUALS

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.
- B. Each Division shall compile and prepare documentation for all equipment and systems covered in that Division and deliver this documentation to the **[Construction Manager] [General Contractor]** for inclusion in the O&M manuals.
  - 1. Field checkout sheets and logs should be provided to the Owner's Commissioning Authority.
  - 2. All documentation shall be made specific to this project by permanently marking "generic" manufacturer's O&M manuals to indicate exactly which models and options are included in the Work of this project.
- C. Deliver the O&M manuals to the Owner's Commissioning Authority for review within 60 days of final review of the submittals of the equipment.
- D. Review and Approvals: Review of the commissioning-related sections of the O&M manuals shall be made by the Design Professional and by the Owner's Commissioning Authority.

### 3.12 TRAINING OF OWNER PERSONNEL

- A. Coordinate and schedule training for Owner's designated personnel.
  - 1. Facilitate a sign-in process and submit sign-in sheet to CxA.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.
- C. Prepare a training outline and submit to Owner's Commissioning Authority for comment and approval. Provide training of the Owner's personnel.

END OF SECTION 01 9113