DESIGN GUIDELINE SID 4.3.3
FULL PROJECT COMMISSIONING

This procedure defines the process for performing full construction-phase commissioning (Cx) on new building, building addition and major renovation projects. When the process is performed by an external commissioning firm, it shall be performed in accordance with the U-M “Terms and Conditions for Professional Services”.

Construction-phase commissioning is a process by which a building Commissioning Authority (CxA) verifies the project is built, operated and maintained as intended by its Design Team and its Owners. The scope of work shall consist of all applicable activities identified below. Construction-phase commissioning shall begin during the design development (DD) phase on a LEED project, or during the construction documents (CD) phase on a non-LEED project. It shall continue through Substantial Completion (SC) and occupancy.

All work shall be performed in accordance with Federal, State, University of Michigan, UMHHC and construction manager (CM) or general contractor (GC) safety requirements for working on University property. These requirements include but are not limited to following security and access control procedures, wearing mandated personal protective equipment, and attending a site-specific safety training orientation prior to entering construction zones.

1. Visit and become familiar with the project site.

2. If the project is pursuing LEED Certification, review and submit written comments to the A/E on the DD level Owner’s Project Requirements (OPR) and Basis of Design (BOD) documents.

3. If the project is pursuing LEED Certification including the LEED Credit “Enhanced Commissioning”, review and submit written comments to the A/E on the project's DD design documents during the Owner's Review of the DD documents.
   • Verify the DD documents accurately reflect the OPR and BOD.
   • Verify the DD documents employ good design practices.

4. Using the completed DD design documents, edit U-M Master Specification 01715, "Full Project Commissioning".
   • Coordinate the names and numbers of the related Division 1 specifications.
   • Identify systems to be commissioned and make the specification project specific.
   • Submit the specification to the Architect/Engineer (A/E) (through the U-M Design Manager) for incorporation in the CD specifications.

5. Review and submit written comments to the A/E on the project’s CD design documents during the Owner's review of the CD documents.
   • Verify the CD documents accurately reflect the OPR and BOD.
   • Verify the CD documents include all commissioning-related issues. Identify errors and omissions that will inhibit commissioning of the project.
• Verify the CD documents include complete performance and acceptance criteria for the systems and equipment being commissioned.

6. Develop a project-specific commissioning manual. Utilize the U-M "Generic Sample Commissioning Manual" and make it project specific. This manual will be the commissioning plan.

7. Conduct an on-site commissioning kick-off meeting.
   • Require each contractor’s lead field person and commissioning lead person to attend.
   • Clarify the requirements and benefits of the commissioning process.
   • Write and distribute commissioning meeting minutes.

8. Issue the project-specific Cx manual to the CM or GC. Instruct them on how to maintain and complete it.
   • Develop and issue the draft Cx forms for contractor completion and insertion into the Cx manual.
   • Require each contractor to complete, sign, and insert the portion of each form that relates to their work.
   • Require each contractor to insert copies of all manufacturer inspection, start-up and field service reports.
   • Require each contractor to insert copies of all lubrication, filter change and maintenance records on systems and equipment used for temporary service.

9. Conduct periodic on-site commissioning meetings typically once every month early in the project, increasing to once every two weeks during the middle portion of the project, and further increasing to once every week for the last third of the project.
   • Insist upon CM or GC participation in all meetings. Require contractor participation in meetings as appropriate. Notify the Project Manager of contractors who routinely fail to attend.
   • Write and distribute commissioning meeting minutes. Indicate which contractors attended and which failed to attend.

10. Participate in the contractor shop drawing submittal review process and send comments to the A/E. Review comments should be declarative, assertive and direct.
    • Establish a parallel review process where the A/E considers and incorporates commissioning comments into the A/E’s comments, or contacts you to discuss. Copy the Project Manager when submitting comments to the A/E.
      o Review the submittals which are critical to the Cx process.
      o Focus on identifying issues that will prevent successful commissioning. Typical examples include performance data that does not meet project requirements, alarm contacts not provided for DDC, unclear sequences of operation, inadequate service and electrical clearances.
      o Generally verify compliance with plans and specifications, and focus on issues that are often overlooked. Typical examples include un-approved manufacturers
(including motors provided with equipment), sub-components (such as motors and valves) not in compliance with related specification sections, etc.

- Obtain a set of the A/E reviewed and stamped submittals for your file. Notify the Project Manager if your comments were not incorporated.

11. Develop the project commissioning sequence, the intent of which is to assure all prerequisites are complete for each system's functional testing.
   - Create system specific progress check sheets for the systems to be commissioned.
   - List the items, in the required sequence, which must be completed before functional testing can occur.
   - Include brief system descriptions with pertinent facts that will assist during commissioning.

12. Identify equipment or systems (including pre-purchased equipment) requiring factory or on-site testing, or other special documentation.
   - Require such tests be performed. Verify documentation is inserted into the commissioning manual.
   - When the CxA must witness factory tests, the project shall pay for travel-related expenses.
   - Review equipment test reports or similar reports significant to the commissioning effort.
   - Participate in the resolution of issues brought to light as a result of such testing or reports.
   - Document the final resolutions in the Cx manual.

13. Facilitate integration of commissioning events into the CM’s or GC’s CPM project schedule.
   - Develop a logical duration, order and timing for each commissioning event, and provide to the CM or GC.
   - Require the CM or GC to account for commissioning events in the project schedule to allow completion of all functional testing activities prior to Substantial Completion.
   - When a system or equipment is being started early to facilitate construction, remind the CM or GC that the early-started systems and equipment shall be commissioned once before start-up and a second time before final acceptance.

14. Perform periodic on-site construction observation of equipment and materials related to systems being commissioned. Document any quality control deficiencies found.
   - For components critical for a system to deliver the performance required to meet the OPR and BOD, spot check that proper materials and installation methods were utilized. Examples include proper vibration isolation, proper pipe materials and joining methods, ducts and piping properly protected from dirt while stored, improper clearances that will impact performance or maintainability, equipment not installed per manufacturer’s recommendations.
     - Spot check equipment and materials such as motorized dampers, motors, specialty duct work, etc., for compliance with specifications and the A/E approved shop drawing submittals.
     - Stay alert for and report gross deficiencies such as missing piping expansion loops and relief valves, and sub-standard materials.
- Maintain an open issues log and frequently provide a copy to the Project Manager and CM or GC.
- Insist that deficiencies be documented by the CM or GC, and insist they remain on the CM's or GC’s list of incomplete and deficient work until they are completely corrected.

15. Facilitate UM Plant Operations, UMHHHC, OSEH, and Department of Public Safety participation in special inspections and tests (roofs, sprinklers, elevators, fire alarm systems, security systems, etc.)

16. Generate Requests For Information (RFIs) to the A/E relating to questions on design intent or functionality issues on commissioned systems, and follow up on closure of all such issues.

17. Assist the contractor with generating RFIs related to their questions on design intent or functionality issues on commissioned systems, and follow up until closure of all such issues.

18. Review RFI responses related to commissioned systems and equipment for correctness and project specificity.

19. Participate in the coordination drawing process.
   - Attend a minimum of five contractor coordination drawing meetings. Monitor the process to verify reasonable coordination is occurring between trades. Report on contractor progress.
   - Assist contractors in identifying required equipment maintenance access and require maintenance access spaces be delineated on the coordination drawings.
   - Ductwork and piping used for temporary heat, temporary ventilation, temporary fire protection or other temporary service often are missed in the coordination drawing process, especially if installed early in construction. Promote inclusion of temporary work to avoid interferences with permanent work.
   - Insist temporary ductwork and piping be installed in accordance with specification requirements for permanent work. There may be an attempt to declare temporary work as permanent later. Therefore, insist temporary duct and pipe routes, hangers, supports, fittings, valves and valve locations, taps and tap locations, wall and floor penetrations, etc. comply with specification requirements for permanent work.

20. Promote the use of mock-ups to improve quality and reduce re-work. Review and provide comments on completed mock-ups.

21. Develop, with contractor assistance, pre-installation check sheets.
   - Identify equipment requiring such sheets (all major equipment).
   - Itemize key specification and installation requirements on the check sheets.

22. Assist the contractor in developing logical and adequate flushing and cleaning plans for plumbing and hydronic piping systems.
   - Review the specification requirements for flushing and cleaning, disinfecting and chemical treatment. Validate contractor compliance throughout construction.
• Review contractor flushing and cleaning plans.
• Witness 100 percent of the flushing and cleaning of these systems.
• Assure chemical testing of the cleaned systems.
• Assure disinfecting of potable water systems.
• Assure that the initial water treatment of each hydronic system occurs immediately after flushing and cleaning is complete.
• Assure that chemical treatment is maintained while the system is operated by the contractor. Do this by requiring that validating reports be provided by the chemical services provider and inserted into the Cx manual after every visit.

23. Participate in contractor duct leak testing.
• Review and approve duct leak testing plans.
• Witness 100 percent of duct leak tests.
• Witness 100 percent of follow-up leak tests.

24. Develop, with contractor assistance, equipment pre-start check lists.
• Identify equipment requiring such sheets (all major equipment).
• Review equipment installation/start-up manuals for equipment being commissioned and incorporate manufacturers' requirements into the pre-start check lists.

25. Develop, with contractor assistance, check/test/start (CTS) and functional test procedures.
• Develop forms to document the start-up and initial testing of equipment requiring commissioning.
• Include all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
• When systems or equipment (including pre-purchased equipment) require the manufacturer’s presence at start-up, verify a manufacturer’s representative is present.
• Witness the CTS of major equipment.

26. Generate and issue periodic commissioning reports. Identify systems that do not meet the OPR or BOD.
• Immediately before Substantial Completion is declared, publish a report documenting the status of all commissioning activities including incomplete commissioning and problems identified as a result of commissioning.
• Provide this report to the Project Manager for attachment to the Notice of Substantial Completion.

27. On projects providing a new or replacing an existing power distribution system, participate in the contractor’s energization of the system.
• Review the final short circuit, protective device coordination and arc flash hazard study provided by the A/E. Identify secondary fuse sizes, breaker settings and automatic transfer switch settings that are missing.
• The electrical testing agency will document in test reports the fuse sizes, breaker settings and ATS settings installed in most of the equipment. Compare them with the A/E’s report and identify discrepancies. Verify with contractor help the fuse sizes and equipment settings not included in test reports to achieve 100 percent verification.
• The U-M Electrical Inspector will compare the equipment numbers on installed flash hazard labels to the numbers on the equipment. Document that this comparison has been completed, or complete the comparison if any installed labels were not checked.
• Verify electrical equipment and cables have passed the specified electrical testing.
• Witness equipment energizations and start-ups of major electrical equipment.

28. Participate in the functional testing and commissioning of each system. Participate in 100 percent of functional testing of major equipment and a spot check of fan coil units, VAV boxes, plumbing fixtures, and similar high unit count equipment.
• Commission project equipment used for temporary heat, temporary ventilation, temporary power or other temporary service twice; once after initial start-up and a second time before being accepted by the University at Substantial Completion.
• Verify the system and its components are securely mounted, level, clean, lubricated, and in new condition.
• Verify the system and its components are installed with adequate maintenance accessibility.
• Witness the testing of all system functions including all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
• Participate in the testing of all system controls, safeties, indictors and alarms.
• Verify the system and components operate per the design intent.
• Document all issues revealed as a result of commissioning.
• Verify all documented issues are resolved.
• Advise the A/E of design problems.
• Document separately issues that cannot be corrected within the project scope.

29. Assist the contractor in organizing an effective air and water, test and balance (T&B) effort.
• Verify the air and water balances are being performed by the same T&B contractor.
• Conduct air and water balance "pre balance" conferences.
• Verify air and water balance procedures proposed by the T&B contractor are appropriate for the project.
• Monitor air and water balance activities.
• Review air and water balance reports.
• Identify incorrectly balanced systems, incomplete balancing, insufficient balancing data, and system deficiencies identified as a result of the balance work.
• Verify any incomplete T&B work is completed and any system deficiencies identified during the balances are rectified.

30. On projects providing a new or replacing an existing power distribution system, perform a "pull the plug" test of the system.
• Arrange for a test in which normal primary power to the building is shut off.
31. Review and approve the project O&M manuals. Verify compliance to Master Specification 01782.
   • Verify the manuals are comprehensive and project specific.
   • Verify the manuals contain as-built information showing equipment revisions.
   • Verify the manuals contain full information from equipment nameplates. Clear, legible photographs are acceptable.
   • Verify the manuals contain schedules of maintenance parts such as belts and filters.
   • Verify the manuals contain as-built electrical panel schedules.
   • Verify the manuals are properly distributed to appropriate Owner personnel.

32. Assist the contractor with organizing and conducting Owner training sessions.
   • Verify the contractor organizes the vendor training required by the specifications.
   • Determine attendance requirements via communication with the Owner’s Plant Operations or UMHHC training coordinator.
   • Propose training schedules for Owner approval.
   • Notify Owner’s personnel of each training session and track their attendance through completion.
   • Develop an outline style training document generally describing each major system, areas served etc. that will assist maintenance personnel in becoming familiar with each system.
   • Verify that vendors conducting training sessions are fully knowledgeable and prepared to provide thorough training sessions. If a training session is found to be inadequate, insist the session be cancelled and rescheduled.
   • Provide system "overview" training in conjunction with equipment-specific training.
   • Document each training session (trainer, attendance, date, time, location, and brief report).

33. If the project is pursuing the LEED Credit "Enhanced Commissioning", develop a systems manual.

34. Perform commissioning closeout.
   • Review and approve the final commissioning manual submittal.
   • Verify that all project commissioning requirements have been met.

SPECIAL INSTRUCTIONS TO DESIGNERS
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35. Generate and issue a final commissioning report within 30 days of Substantial Completion. If commissioning activities are not complete at this time, issue a supplement to the final Cx report when commissioning is finished.

36. If the project is pursuing the LEED Credit “Thermal Comfort-Verification”, facilitate an occupant thermal comfort survey.
   - Notify the AEC Sustainability Team of Substantial Completion and provide them with the Facility Manager's contact information.
     - Eight months after Substantial Completion, the Sustainability Team will ask the Facility Manager for an e-mail list of the building's full time occupants.
     - The Team will e-mail an occupant thermal comfort survey to the building's full time occupants. Response time will be limited to ten working days.
     - The Team will collate and summarize the responses, and submit their summary to the CxA and Facility Manager.
   - If the survey responses indicate 20 percent or more of the occupants are uncomfortable, determine if the building is operating outside of the environmental conditions in the OPR.
   - If the building is operating outside of the environmental conditions in the OPR, coordinate with the Facility Manager and maintenance staff, and implement a corrective action plan.
   - Document the survey results and corrective actions taken in the systems manual.

37. If the project is pursuing the LEED Credit “Enhanced Commissioning”, review the project's operation and maintenance approximately nine to ten months after Substantial Completion.
   - Review the results of the occupant thermal comfort survey and any corrective actions taken.
   - Review the operation and maintenance of building systems with the maintenance staff and occupants. Identify systems and equipment not being operated or maintained in accordance with the OPR and BOD, and document them in the systems manual.
   - Identify deficiencies requiring contractor correction and facilitate their correction before expiration of the project's warranty.
   - Document in the systems manual any deficiencies not being corrected.