SECTION 01 9100

COMMISSIONING

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LANL MASTER SPECIFICATION SECTION

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| Rev. 0 Summary of Changes: initial issuance |

This template must be edited for each project. In doing so, specifier must add job-specific requirements. Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer. Once the choice is made or text supplied, remove the brackets. Delete requirements for processes, items, or designs that are not included in the project -- and specifier’s notes such as these. To seek a variance from requirements that are applicable, contact the Engineering Standards Manual (ESM) Commissioning [POC](https://engstandards.lanl.gov/POCs.shtml#commissioning). Please contact the POC with suggestions for improvement as well.

Section developed for Management Level (ML)-4 projects. For ML-1, 2, and 3 applications, additional requirements and independent reviews should be added if increased confidence in procurement or execution is desired; see ESM Chapter 1, Section Z10 Specifications and Quality sections.

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1. GENERAL
	1. SECTION INCLUDES
		1. Responsibilities of Construction Subcontractor and other key personnel in the commissioning (Cx) process, particularly the Commissioning Agent (CxA).
		2. Note: Other Project Specification Sections may require additional test and inspections that are in addition to this Section; coordinate the tests required in this Section with all test and inspection plans that may be developed for the Project.
	2. RELATED SPECFICATION SECTIONS
		1. 23 0593, *Testing, Adjusting, and Balancing for HVAC*
		2. 23 0800, *Commissioning of HVAC Systems*
		3. 25 5000, *Integrated Automated Facility Controls*
		4. 26 0813, *Electrical Acceptance Testing*
	3. COMMISSIONING DESCRIPTION
		1. This section is the basis of the project Cx interface, roles and responsibilities, process, and procedures.
		2. Various sections of the Project Specification require equipment startup, testing, and adjusting services. The Subcontractor shall coordinate the work required by individual Specification Sections with the Cx services requirements specified herein.
		3. Cx is a systematic process of verifying that the building systems perform interactively according to the design documents, manufacturer’s recommendations, and the operational needs. The Cx process shall encompass and coordinate the system documentation, equipment startup, control system operation, instrumentation calibration, testing, adjust and balance, performance testing and training. Cx during the construction and Cx phases is intended to achieve the following specific objectives:
			1. Verify that the applicable equipment and systems are installed in accordance with the design documents and according to the manufacturer's recommendations.
			2. Verify and document proper integrated performance of equipment and systems.
			3. Verify that Operations & Maintenance documentation is complete.
			4. Verify that all components requiring service and maintenance can be accessed, serviced, and removed without disturbing nearby components including ducts, piping, cabling, or wiring.
			5. Verify that the operating personnel receive training to enable them to operate, monitor, adjust, maintain, and repair building systems in a safe, effective, and efficient manner.
			6. Document the successful achievement of the Cx objectives.
		4. The Cx process does not reduce the responsibility of the Subcontractor to provide a finished and fully functioning product. Rather, it is a process by which to verify this function has been completed successfully.
	4. DEFINITIONS
		1. Acceptance Test Procedure – Written detailed step-by-step protocol that defines the means and methods, personnel, and expectations for conducting tests on components, equipment, assemblies, systems, and system interfaces. The procedure has provisions for verifying all relevant data, recording results, and identifying the requirements and responsibility for each test; also referred to as Functional Test Procedure.
		2. Accuracy – The capability of an instrument to consistently indicate the true value of a measured quantity.
		3. Commissioning Agent (CxA) – A qualified and experienced Cx process person, company, or agency assigned to a specific project, working under the guidance of the LANL Commissioning Authority (LCA) and the LANL Project Manager. The CxA leads, plans, coordinates and implements the overall project-specific Cx process activities. Qualification is per the judgment of the LCA. The CxA shall be directly accountable to the LCA. The CxA shall not be a subcontractor to any LANL Subcontractor.
		4. Cx Design Review – The Cx design review is a collaborative review of the design professionals design documents for items pertaining to the following: owner’s project requirements; basis of design; operability and maintainability (O&M) including documentation; functionality; training; energy efficiency, control systems’ sequence of operations including building automation system features; Cx specification sections and the ability to functionally test the systems.
		5. Commissioning Plan (Cx Plan) – A high level document that defines the Cx process, including roles, responsibilities, document requirements, and Cx test requirements. The Cx plan is not a test procedure; it provides the framework by which testing will be planned and executed.
		6. Cx Process – A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and its systems, components, and assemblies are planned, designed, installed, tested, can be operated, and maintained to meet the Owner's Project Requirements.
		7. Cx Program – An established process in which an organization executes Cx activities over all phases of projects.
		8. Cx Team – Multi-disciplinary team whose coordinated actions are responsible for implementing the Cx Process.
		9. Component Test – Tests performed to demonstrate specific equipment functionality and documentation of results via formal test records or installation data sheets.
		10. LANL Commissioning Authority (LCA) – An independent Cx process person designated by the LANL Construction Management Division to manage Cx at LANL and, for facilities, to represent the LANL Building Official’s interests in matters related to Cx.
		11. Precision – The ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.
		12. Pre-Functional Checklists – A form developed by the CxA and completed by the Subcontractor to verify that appropriate components are onsite, correctly installed, set up, calibrated, functional and ready for Component and Acceptance Testing.
		13. System Acceptance Test – Tests by which specific components, equipment, assemblies, systems, and system interfaces are confirmed to comply with the criteria described in the [Owner’s Project Requirements]. This includes all modes and sequences of control, safety interlocks, conditional control responses and all specified responses in accordance with design basis requirements.
		14. Test Deficiency – A condition identified by the CxA or other member of the Cx Team that adversely affects the ability to commission, operate, maintain, or function a system, equipment, or component. A condition conflicting with the Design Documents and/or performance requirements of the installed systems and components. Each Deficiency will be documented together with its resolution.
		15. Test Summary Report – The documentation package that summarizes the Cx plan, test procedures and results of the Cx process. The summary report addresses the recorded performance of the various systems/components, deficiency resolution, and a chronology of events; also referred to as Final Cx Report.
		16. Testing, Adjusting, and Balancing (TAB) – A systematic process or service applied to heating, ventilating, and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as “Testing, Adjusting, and Balancing” and are described in the Procedural Standards for the Testing, Adjusting and Balancing of Environmental Systems, published by NEBB or AABC.
		17. Test Review Board (TRB) – The group of representatives from the Design Authority, Quality Assurance, LANL Engineering, LANL Startup and Testing Services Group, and Facility Operations responsible for reviewing and approving Cx test results.
	5. QUALITY ASSURANCE
		1. CxA will be appointed and approved by the LCA; CxA services will be provided by LANL Startup and Commissioning Group or Subcontracted by LANL and overseen by LANL Startup and Commissioning Group.
			1. The CxA is an independent testing organization that functions as an unbiased testing authority, professionally independent of the manufacturers, suppliers, constructors and installers of the equipment or systems to be evaluated.
			2. The CxA will have a testing program that meets or exceeds the requirements of [ASME NQA-1-2008] or other national standard accepted by the LCA.
		2. Subcontractor and CxA Technician Qualifications
			1. Each technician who performs component or acceptance testing, inspection, calibration, and adjustments shall be a Level II or III qualified person as defined by ASME NQA-1 [2008].
			2. Technicians performing these tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated.
			3. Technicians shall be capable of conducting the tests in a safe manner with complete knowledge of the hazards involved and the appropriate safety-related work practices.
			4. Technicians shall be qualified to evaluate the test data and make a judgment on the serviceability of the specific equipment.
		3. Electrical Acceptance Testing Agency shall meet all requirements documented in Section 26 0813 (e.g.,1.3 QUALITY ASSURANCE).
	6. GRADED APPROACH
		1. The graded approach outlined in STD-342-100, *LANL Engineering Standards Manual*, Chapter 15, Commissioning, (e.g., Section 1.0.E Table 1 - Minimum Level of Rigor in Cx) will be used to determine the level of rigor for acceptance testing.
	7. CX DOCUMENTATION
		1. CxA will develop the following for review and approval from the LCA or designee prior to the start of testing:
			1. CxA’s Cx program description and process procedures for conduct of Cx
			2. Project Commissioning Plan
			3. Test sequence and schedule
			4. Component test procedures and data sheets
			5. Test instrument calibration data sheets
			6. System Acceptance Test Procedures
			7. Commissioning personnel qualifications
	8. SYSTEMS TO BE COMMISSIONED

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Note: Tailor the list to include all applicable systems and ancillary associated equipment included in project scope and none outside the scope.

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* + 1. [HVAC Components
			1. Air Handling Unit(s)
			2. Chillers
			3. Boilers
			4. Cooling Towers
			5. Piping Systems
			6. Ductwork
			7. Variable Frequency Drives
			8. Packaged AC units
			9. Terminal Units
			10. Unit Heater
			11. Computer Room Air Conditioning Units
			12. Fume Hoods
			13. Exhaust Fans
			14. Make-up Air System
			15. Variable Refrigerant Flow System
		2. Mechanical
			1. Pumps
			2. Vacuums
			3. Process Water Systems
			4. Compressed Air Systems
		3. Electrical
			1. Motor Control Centers
			2. Transformers
			3. Distribution Panels
			4. Power Quality
			5. Transfer Switches
			6. UPS systems
			7. Lighting Controls
			8. Emergency Lighting
		4. Process/Programmatic
		5. Instrumentation and Controls
		6. Building Automation Systems
		7. Safety Systems]
	1. CX Roles and Responsibilities
		1. LANL Project Manager (PM)
			1. Approve the scope of Cx services required and contacts LCA to arrange for such services (in-house and/or subcontract).
			2. Ensure funding is available to support programs and personnel necessary to accomplish the Cx testing scope of work.
			3. Ensure funding and resources are available for the Test Review Board (TRB) representatives and facilitates their efforts in reviewing and approving project Cx test results.
			4. Review and approves the Cx plans and procedures.
			5. Review and approves the Final Test Summary Report.
			6. Ensure construction subcontracts direct the cooperation of the constructor (e.g., through exhibits or Specification sections).
		2. Responsible Subject Matter Expert (SME)
			1. Participate as a member of the Cx team and provides technical input as required.
			2. Support and witness field Cx tests, as necessary.
			3. Review and approve Cx plans and other documents as submitted by the CxA.
			4. Review and approve Test Deficiency Report / Issues and Resolutions.
		3. LANL Commissioning Authority
			1. Act as point-of-contact (POC) and support for all Cx issues.
			2. Assigns resources (LANL or subcontract) to complete required Cx scope.
			3. Review CxA status reports.
			4. Establish, review, and accept the CxA’s qualifications for a project assignment.
			5. Review and approve the qualifications of subcontractor CxA team members.
			6. Review and approve all Cx activities conducted by the Project CxA.
			7. Participate in project reviews as required.
			8. Review and approves the Test Summary Report.
			9. Ensure test personnel hold a current NQA-1 Level II qualification, at a minimum.
		4. Commissioning Agent (CxA) (LANL or Independent Third Party)

		The CxA’s roles and responsibilities must align with the contractual requirements established for the project. The specific requirements may significantly change based on design and construction approach (e.g., design-bid-build, design-build) selected by the Project Manager.
			1. Establish the Cx Plan and coordinate the Cx Team
			2. Provides support to the owner to evaluate and verify that the owner’s project requirements for the facility are satisfactorily achieved and documented during all phases of the project.
			3. Develop the Cx process, plan, documentation, data sheets and system acceptance test procedures, and requirements throughout the life of the project.
			4. Provide cost estimates and duration of Cx activities for budgetary planning and scheduling.
			5. In conjunction with the LCA, establish a Project Commissioning Team and define roles and responsibilities.
			6. Plan the sequence of test activities and develop a Cx schedule for integration into the project schedule
			7. Coordinate the Cx activities in a safe, logical, sequential, and efficient manner utilizing standardized protocols defined in AP-350-406.
			8. Develop pre-Cx requirements to be completed by Subcontractor prior to system acceptance for Cx.
			9. Conduct electrical acceptance testing in accordance with requirements of LANL ESM Chapter 15 vendor instructions and project specifications.
			10. Conduct component level testing of fans, pumps, motors, etc. in accordance with the requirements of LANL ESM Chapter 15 vendor instructions and project specifications.
			11. Conduct acceptance testing of system/building automated controls in accordance with the requirements of LANL ESM Chapter 15, project specifications, sequence of operations, and vendor equipment control instructions.
			12. Conduct system acceptance tests and/or integrated process system tests.
			13. Documents test procedure changes, test deficiency reporting, tracking and resolution.
			14. Complete Test Summary Report as final Cx report of Cx process that was conducted
			15. Define the Cx requirements and activities to the construction manager, subcontractors, architect/engineer of record, and the project manager to ensure that Cx activities are included in the master design and construction schedules.
			16. Plan and conduct Cx planning meetings.
			17. Review design and construction documentation with respect to Cx requirements.
			18. Review design and construction installation verification reports and Cx test data.
			19. Identify, document and report Cx test deficiencies. Coordinate re-testing as necessary, until satisfactory performance is achieved.
			20. Maintain a test deficiency report log.
			21. Provide to the owner/project manager, as required, written progress reports and test results with recommended actions.
			22. Review nonconformance and corrective action documentation that has a Cx impact.
			23. Review the Cx documentation utilized to establish Cx acceptance.
			24. Support the review of O&M submittals from a life-cycle O&M perspective, as required.
			25. Provide coordination with the construction Subcontract Technical Representative (STR) for vendor training of owner personnel.
			26. Observe components and systems installations. Attend planning and job-site meetings to obtain information on construction progress.
			27. Witness Cx tests when performed by subcontractors, vendors, or independent agencies to assure that proper procedures are being followed. Test documentation will be provided to CxA for review and validation of acceptable results.
			28. Conduct retests of systems or components which failed the initial testing requirements.
			29. Develop System Integrated Test Procedures when required.
			30. Work with the installing subcontractors and include data from vendor tests.
			31. Analyze all test data collected to verify actual performance results for inclusion into the final Cx report and when required submit for TRB approval.
			32. Prepare Pre-Functional Checklists and distribute to Subcontractor for completion. Review Pre-Functional Checklists to verify accuracy and readiness for testing. Inaccurate or incomplete Pre-Functional Checklists will be returned to the Subcontractor for correction and resubmission.
		5. Construction Subcontractor
			1. Interfaces with the CxA via the STR.
			2. Assign a person to manage Cx activities of the Subcontractor and their sub-tier subcontractors.
			3. Ensure that all Cx commitments included in their scope of work and outlined in this Specification are included in all subtier subcontracts — and their sub-tier contractors comply with the requirements.
			4. Ensure that they themselves and each installing Sub-tier Subcontractor assigns representatives with expertise and authority to act on their behalf and schedule them to participate in and perform Cx team activities including, but not limited to, the following:
				1. Participate in Cx coordination meetings.
				2. Conduct operation and maintenance training sessions in accordance with approved training plans.
				3. Verify that work is complete and systems are operational according to the design documents, including calibration of instrumentation and controls.
				4. Evaluate Cx issues and Cx observations identified in Commissioning Test Deficiency Reports, field reports, test reports or other Cx documents. In collaboration with CxA and the entity responsible for system and equipment installation, recommend and address corrective actions.
				5. Review and comment on Cx documentation.
				6. Participate in meetings to coordinate Systems Functional Performance Testing.
				7. Provide information to the CxA for developing Cx documentation.
				8. Coordinate and participate in training sessions for the Owner's operation and maintenance personnel.
				9. Provide technicians who are familiar with the construction and operation of installed systems and specific test procedures to support Systems Functional Performance Testing of installed systems.
			5. Pre-Functional Checklists shall be completed and signed by the Subcontractor, verifying that systems, subsystems, equipment, and associated controls are ready for testing.
			6. During any Cx activities conducted by the Subcontractor or their Sub-Tiers, notify a LANL Cx representative to witness all or portions of startup and Cx work.
	2. COORDINATION
		1. CxA will coordinate the Cx activities with the Project Team and Subcontractor through their STR. The CxA will provide Cx documents and information to the Cx Team as outlined in the Cx Plan. All Cx team members shall work together to fulfill their responsibilities and meet the objectives of the Cx process.
		2. CxA will work with the Subcontractor and the Project Team to incorporate the Cx activities into the project schedule. The CxA will provide sufficient information (including, but not limited to, tasks, durations, predecessors, and successors) on Cx activities to allow the Subcontractor and the Project Team to schedule Cx activities.
		3. CxA will provide the initial sequence of primary Cx events in the Cx Plan and at the Cx coordination meetings. As construction progresses, more detailed schedules will be developed by the Contractor with information from the CxA.
		4. CxA will conduct periodic Cx Coordination Meetings of the Cx team to review status of Cx activities, to discuss scheduling conflicts, and to discuss upcoming Cx process activities.
		5. CxA may conduct pretest meetings of the Cx team to review startup reports, Pre-Functional Checklist results, Systems Acceptance Test procedures, testing personnel and instrumentation requirements.
		6. The CxA will endeavor to notify the LANL STR at least 14 days in advance of scheduled Cx activities.
			1. Notify the LANL STR again approximately 24 hours before the start of specific Cx activities.
			2. The LANL STR will notify Subcontractor and manage coordination between Subcontractor and CxA.
	3. FIELD QUALITY CONTROL
		1. The Subcontractor is responsible for warranty of systems, structures, and components (SSCs) until [project milestone] has been attained.
1. PRODUCTS
	1. TEST INSTRUMENTS
		1. Testing parties shall furnish all instruments required for test and Cx activities contained in their scope of work.
		2. Testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. All equipment shall be calibrated according to the LANL Policy P330-2, *Control and Calibration of Measuring and Test Equipment (M&TE)*, (e.g., Section 3.4.3.b.4 Assignment of Calibration Intervals) -- or LANL-approved equivalent -- and following any repairs to the equipment. Calibration tags shall be affixed and certificates available upon request.
2. EXECUTION
	1. GENERAL
		1. Engage personnel experienced in the technical aspects of each system to be commissioned if necessary to augment the expertise of the CxA.
		2. Cx Plan defines the Cx process to be implemented for the project. The plan lists the names of the Project Cx Team and their roles and responsibilities to the Cx process. The plan will list the systems to be tested and the method used for deficiency reporting, tracking, and resolution.
		3. The Acceptance Test Procedures must confirm the performance of systems to the extent of the intent/basis of design and applicable code under which the project was permitted. Emphasize test procedure acceptance criteria that will provide objective evidence of the actual system performance and compliance with the design. When a system is accepted, the Owner and A/E must be assured that the system is complete, functions as intended, is correctly documented, and that the designated Owner staff is trained in the operation and maintenance of the system.
		4. Most equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met. This could include adequate oil pressure, proof-of-flow, non-freezing conditions, maximum head pressure, etc. Acceptance Test Procedures will demonstrate the actual performance of safety shutoffs, alarms, and interlocks in real or closely simulated conditions of failure.
	2. CONDUCT OF TEST
		1. Perform and document component level test in accordance with the applicable Specifications Sections noted below:
			1. Electrical Acceptance Testing as required in Section [ ] and project specific procedures approved by the by the LCA.
			2. Mechanical Acceptance Testing in accordance with Equipment Vendor Test Instructions, Section [ ] and project specific procedures approved by the LCA.
			3. Instrument and Controls Acceptance Testing in accordance with Section [ ] and project specific procedures approved by the LCA.
			4. HVAC Equipment Acceptance Testing in accordance with Vendor Test Instructions, Section [ ], and project specific procedures approved by the LCA.
			5. [HVAC Test Adjust and Balance in accordance with ANSI/ASHRAE IES 90.1, Section [ ] and LANL-approved project-specific test procedures developed by the project CxA.]
		2. System Acceptance Test of systems in accordance with subcontractor test procedures approved by LANL.
		3. Promptly document and report to LANL STR any test deficiencies, equipment failures or tests that do not meet acceptance criteria.
		4. The Subcontractor is responsible for tracking and correcting all deficiencies identified during Cx.
		5. The CxA will re-test any SSC that did not pass acceptance testing.
		6. Notify the LANL STR when equipment or systems are ready for turnover to operating status.
	3. TEST DOCUMENTS

Conduct and document testing per NQA-1 2008 Part I, Requirement 11.

* + 1. Test records shall be established and maintained to indicate the ability of the component, system and/or automation program to satisfactorily perform its intended function or to meet its documented requirements. Test records vary depending on the test type, purpose, and application, but shall contain the following information, as a minimum.
			1. Project title and I.D. number
			2. System title
			3. Component tested
			4. Date of test
			5. Name and signature of the tester or data recorder
			6. Test instruction
			7. Results and acceptability
			8. Action taken in connection with any deviations
			9. Name and signature of person evaluating test results
		2. Automation Program Test Records
			1. Project title and I.D. number
			2. System title
			3. Title, version, and revision of computer software tested
			4. Title, version, and revision of computer hardware tested
			5. Test equipment and calibrations, where applicable
			6. Date of test
			7. Names and signature of tester or data recorder
			8. Copies of screen graphics
			9. Simulation models used, where applicable
			10. Test deficiencies and resolution
			11. Results and applicability
			12. Electronic or hard copy of the as left version of the program
			13. Name and signature of person evaluating test results.

END OF SECTION

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Do not delete the following reference information.

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THE FOLLOWING STATEMENT IS FOR LANL USE ONLY

This project specification section is based on LANL Master Specification Section 01 9100, Rev. 0, dated June 23, 2022.