SECTION 01 9100

COMMISSIONING

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LANL MASTER SPECIFICATION SECTION

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| Rev. 1 Summary of changes:  Incorporated and supersedes Master Specification Section 23 0800 R0, *Commissioning of HVAC,* removed reference to Electrical Acceptance Testing *(*not Commissioning scope; electrical testing is handled during Construction phase of project*)*. |

Word file at <https://engstandards.lanl.gov>

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. Qualifications of Constructor’s Technician’s performing any component or acceptance testing, inspection, calibration, and adjustments shall be submitted for ML-1 through ML-3 projects.

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1. GENERAL
   1. SECTION INCLUDES
      1. Responsibilities of Constructor and other key personnel in the commissioning (Cx) process, particularly the Commissioning Agent (CxA).
      2. Requirements for post-construction phases of the Cx process.
      3. 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 SECTIONS

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Tailor the list to include all applicable systems and ancillary associated equipment included in project scope.

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* + 1. Section 22 0535, *Electric Heat Tracing Systems*
    2. Section 22 1500, *Compressed-Air Systems*
    3. Section 22 3700, *Domestic Water Heaters*
    4. Section 22 4200, *Plumbing Fixtures*
    5. Section 23 0593, *Testing, Adjusting, and Balancing for HVAC*
    6. Section 23 2113, *Hydronic Piping*
    7. Section 23 3101, *HVAC Ducts*
    8. Section 23 3300, *Air Duct Accessories*
    9. Section 23 3400*, HVAC Fans*
    10. Section 23 3816, *Fume Hoods*
    11. Section 23 6200, *Packaged Compressor and Condenser Units*
    12. Section 23 7413, *Packaged, Outdoor, Central-Station Air-Handling Units*
    13. Section 23 8123, *Computer-Room Air-Conditioners*
    14. Section 23 8239, *Unit Heaters*
    15. Section 25 5000, *Integrated Automated Facility Controls*
    16. Section 25 5256, *Building Automation Systems (BAS) Programming*
    17. Section 26 2726, *Wiring Devices*
    18. Section 26 3334, *Stored Emergency Power Supply System*
    19. Section 26 3353, *Static Uninterruptible Power Supply*
    20. Section 26 5100, *Interior Lighting*
    21. Section 26 5200, *Safety Lighting*
    22. Section 26 5600, *Exterior Lighting*
    23. Section 28 4600, *Fire Detection and Alarm*
  1. REFERENCES
     1. AABC, *National Standards for Total System Balance*
     2. ASHRAE 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*

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Designer to update ASME NQA-1 edition based on SD330

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* + 1. [ASME NQA-1 [2008] with NQA-1a-[2009], *Quality Assurance Requirements for Nuclear Facility Applications*]
    2. LANL ESM STD-342-100, Chapter 15, *Commissioning*
    3. LANL Policy P330-2, *Control and Calibration of Measuring and Test Equipment (M&TE)*
    4. NEBB, *Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems*
  1. 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 package require equipment startup, testing, and adjusting services. The Constructor 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.
  2. DEFINITIONS
     1. For definitions and acronyms, refer to COE Glossary of Terms. Definitions exist for the following terms (and others): Commissioning, Constructor, Design Agency, LANL Commissioning Authority, Component Testing, SSC, Subcontractor, Subcontract Technical Representative.
     2. 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.
     3. Accuracy – The capability of an instrument to consistently indicate the true value of a measured quantity.
     4. 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.
     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. Component Testing – The individual pieces of equipment are confirmed to be capable of performing in accordance with the specifications, drawings, and manufacturer’s requirements. This is documented in a component test data sheet provided by and completed by the CxA. *The information recorded on the data sheet provides baseline data for future re-evaluation of the components or systems.*
     7. Constructor - Term for the entity performing fabrication or physical construction activity. Constructor may be a Subcontractor or LANL self-perform entity.
     8. Cx Design Review – The Cx design review is a collaborative review of the design professional’s 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.
     9. 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.
     10. Cx Program – An established process in which an organization executes Cx activities over all phases of projects.
     11. Cx Team – Multi-disciplinary team that coordinates, monitors, and documents compliance with the owner’s project requirements and are responsible for implementing the Cx Process. Cx team personnel are to be independent of the Constructor and are subcontracted separately from the Constructor.
     12. 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.
     13. Installation (Pre-functional) Checklists – A form developed by the CxA and completed by the Constructor to verify that appropriate components are onsite, correctly installed, set up, calibrated, functional and ready for Component Testing and System Acceptance Testing.
     14. 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.
     15. System Acceptance Testing – 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.
     16. 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.
     17. 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 Standard for Testing, Adjusting and Balancing of Environmental Systems*, published by NEBB (National Environmental Balancing Bureau) or *National Standards for Total System Balance* published by AABC (Associated Air Balance Council).
     18. 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.
     19. Test Summary Report (TSR) – A final written report detailing the results of all Component Testing and System Acceptance Testing. This includes a completed version of the commissioning acceptance test procedure, chronological test logs, test deficiency reports, and any other supporting documentation.
  3. 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 commissioning program that meets or exceeds the requirements of [ASME NQA-1] [other national standards accepted by the LCA such as AABC Commissioning Group certification or Building Commissioning Association (BCxA) certification].
     2. Constructor’s Technician’s 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.]
        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.
  4. GRADED APPROACH
     1. The graded approach outlined in STD-342-100, *LANL Engineering Standards Manual*, Chapter 15, Commissioning, (e.g., Table 1 - Minimum Level of Rigor in Cx) will be used to determine the level of rigor for acceptance testing.
  5. CX DOCUMENTATION
     1. CxA will develop the following for review and approval from the LCA or designee prior to the start of testing, unless noted otherwise:
        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. Test Summary Report (available after testing is complete).
  6. SYSTEMS TO BE COMMISSIONED

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Tailor the list to include all applicable systems and ancillary associated equipment included in project scope.

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* + 1. [Plumbing Systems
       1. Electric Heat Tracing Systems
       2. Compressed Air Systems
       3. Domestic Water Heaters/Hot Water Systems
       4. Plumbing Fixtures
    2. 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 Air Handling Units
       9. Packaged Compressor and Condenser Units
       10. Fan Coil Units
       11. Air Terminal Units
       12. Unit Heaters
       13. Computer Room Air Conditioning Units
       14. Fume Hoods
       15. Exhaust Fans
       16. Make-up Air System
       17. Variable Refrigerant Flow System
       18. Electrical Heating Systems
    3. Mechanical
       1. Pumps
       2. Vacuums
       3. Process Water Systems
       4. Compressed Air Systems
    4. Electrical
       1. Transfer Switches
       2. UPS systems
       3. Lighting Controls
       4. Emergency Lighting
    5. Process/Programmatic
    6. Instrumentation and Controls
    7. Building Automation Systems
    8. Safety Systems
    9. Building Envelope System
    10. Fire Alarm Systems]
  1. CX Roles and Responsibilities
     1. Commissioning Agent (CxA) (LANL or Independent Third Party): All subcontracted commissioning requires oversight by LANL Startup and Commissioning. The following responsibilities apply to commissioning performed by LANL Startup and Commissioning or by a subcontracted commissioning agency.
        1. Develops the commissioning plan, procedures, and test-summary report for those systems to be tested by LANL’s Startup and Commissioning.
        2. Reviews the project design drawings and develops a list of project-scoped systems.
        3. Participates and provides comments on the draft and final design reviews. Ensures that systems are designed in a fashion that promotes testing and meets requirements and that acceptance criteria are detailed in the design documentation provided.
        4. Comments on the draft and final-design reviews looking for operability and maintainability of systems and components.
        5. Coordinates with the Construction Manager, STR and Project Manager to develop the scoped-system startup logic and the system sequence for turnover.
        6. Provides the scoped-system’s list to the Project Controls Engineer and the Construction Manager for incorporation into the project detailed-schedule.
        7. Reviews the detailed schedule with the Construction Manager to establish the dates for the system turnover to Commissioning. Turnover dates are listed as discrete activities in the project schedule.
        8. Coordinates with the Project Manager, STR and Construction Manager on planning and scheduling of the commissioning activities.
        9. Coordinates and accepts the turnover of scoped systems from the Construction Manager.
        10. Coordinates LANL’s lock out/tag out (LOTO) procedures for systems under the CxA’s custody and control with the Construction Manager or STR.
        11. Places jurisdictional tags on equipment turned over for commissioning.
        12. Acts as the Test Director directing all testing activities in a safe and coordinated manner.
        13. Provides the appropriate level of supervision to Constructor’s Startup Testing Agencies and Vendors, coordinated by STR.
        14. Provides the support to Constructor’s Startup Testing Agencies and Vendors; Witnesses Constructor’s startup testing activities and reviews associated documentation.
        15. In conjunction with LANL STR develops Turnover Checklists for Constructor, to be completed prior to scoped systems turnover to LANL CxA.
        16. Witnesses commissioning tests when performed by Constructor or independent agencies to ensure that proper procedures are being followed and to validate acceptable results.
        17. Consults with the Project Engineer (PE) on technical matters related to commissioning.
        18. Consults with the equipment Subject Matter Experts (SMEs) on technical matters related to commissioning.
        19. Consults with the Quality Representative on quality matters related to commissioning.
        20. Coordinates with the Readiness Team to ensure the proposed commissioning procedures address the concerns that affect readiness.
        21. Coordinates with the Facility Operations Group when conducting test activities in the field.
        22. Notifies all members of the Commissioning team of the planned system-testing activities.
        23. Reports status and progress of system-acceptance testing activities to the Integrated Project Team (IPT) and the LCA.
        24. Initiates a Test Deficiency Report (TDR) to document testing deficiencies, equipment failures, or systems failures to meet test-acceptance criteria.
        25. Turns back systems or components found to be deficient to the Construction Manager for re-work or repair.
        26. Replaces jurisdictional tags on equipment returned to the Construction Manager.
        27. Reviews procedures for, and witnesses, the vendor’s factory-acceptance testing.
        28. Reviews and approves system acceptance test procedures and test summary reports for those systems to be tested by Constructor.
        29. Observes component and system installations.
        30. Attends planning and job-site meetings to obtain information on construction progress.
        31. Conducts re-tests of systems or components that failed initial-testing requirements.
        32. Develops system-acceptance test procedures.
        33. Analyzes test data for inclusion into the TSR for submittal and approval.
        34. Coordinates with the Management Self-Assessment (MSA) team to ensure the proposed commissioning procedures address concerns that affect MSA acceptance.
        35. Ensures operations personnel receive required Constructor-furnished training.
        36. Participates as a member of the TRB, if applicable
     2. Constructor
        1. Develops the System Acceptance Test Procedures and TSR for those systems to be tested by Constructor.
        2. Completes all startup activities required by project specification sections (PART 3).
        3. Completes and submits turnover checklists. The CxA’s review and approval is required prior to system acceptance for turnover.
        4. Provides all equipment maintenance and care records prior to turnover to the CxA to include, but not limited to, records made during storage and after installation, e.g., rotation of shafts for rotating mechanical equipment.
        5. Provides labor, vendor, and lower-tier subcontractor services to support commissioning activities in accordance with the subcontract.
        6. Adheres to the project commissioning sequence and schedule.
        7. Provides operations and maintenance documentation.
        8. Provides a list of turnover exceptions to the STR for CxA approval prior to the transfer of scoped systems to LANL Commissioning.
        9. Includes as-built documentation in the Turnover Package (TOP) prior to the transfer of scoped systems to LANL Commissioning. Redlined drawings may be used to reflect field as-built conditions.
        10. Completes installation in accordance with drawings and specification package and makes turnover of components and systems to the CxA, when ready, for LANL Commissioning.
        11. Coordinates with the CxA and STR to keep aware of current, planned, pre-functional, and acceptance test activities.
        12. Supports the opening and closing of any electrical systems, equipment, or panels for CxA inspection prior to transfer to LANL Commissioning.
        13. Supplies labor and materials required to correct deficiencies found during acceptance testing.
        14. Installation (Pre-functional) Checklists shall be completed and signed by the Constructor, verifying that systems, subsystems, equipment, and associated controls are ready for testing.
        15. During any Cx activities conducted by the Constructor 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 Integrated Project Team and Constructor 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 Constructor and the Integrated 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 Constructor and the Integrated 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 Constructor 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, Installation (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 Constructor and manage coordination between Constructor and CxA.
  3. FIELD QUALITY CONTROL
     1. The Constructor 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 precision and accuracy to test and/or measure system performance with the tolerances specified in the Specification sections. 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 discussing 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 Design Agency must be assured that the system is complete, functions as intended, is correctly documented, and that the Owner’s designated 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. Mechanical Acceptance Testing in accordance with Equipment Vendor Test Instructions, Section [ ], and project-specific procedures approved by the LCA.
         2. Instrument and Controls Acceptance Testing in accordance with Section [ ] and project-specific procedures approved by the LCA.
         3. HVAC Equipment Acceptance Testing in accordance with Vendor Test Instructions, Section [ ], and project-specific procedures approved by the LCA.
         4. [HVAC Test, Adjust and Balance (TAB) in accordance with Section [ ] and project-specific procedures approved by the LCA.
      2. System Acceptance Testing of systems shall be in accordance with Constructor’s test procedures approved by LCA, when applicable.
      3. Initial commissioning shall be performed as soon as subcontract work is completed, regardless of season. (Subsequent seasonal commissioning maybe undertaken at any time thereafter to ascertain adequate performance during peak cooling and heating seasons.)
      4. CxA will verify that systems have been installed, calibrated, and are started and operated according to the vendor/manufacturer documents.
      5. CxA will verify that Test, Adjust, and Balance (TAB) has been completed and that TAB reports have been submitted and deficiencies are corrected.
      6. Promptly document and report to LANL STR any test deficiencies, equipment failures or tests that do not meet acceptance criteria.
      7. The Constructor is responsible for tracking (when applicable) and correcting all deficiencies identified during Cx.
      8. The CxA will re-test any SSC that did not pass acceptance testing.
      9. Notify the LANL STR when equipment or systems are ready for turnover to operating status.
   3. TEST DOCUMENTS
      1. [Conduct and document testing per ASME NQA-1, Part I, Requirement 11.]
      2. 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 Project ID 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
      3. Automation Program Test Records
         1. Project title and Project ID 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. 1, dated September 30, 2024.