SECTION 26 0813

Electrical Acceptance Testing

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LANL MASTER SPECIFICATION SECTION

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

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| Rev. 3 Summary of Changes  Clarified that Section is almost entirely LANL-performed work. For ML-1/2, allowed for LANL personnel to perform work (1.3.G). For ML-3/4 systems, eliminated testing for grounding and some conductors. For VFDs, increased threshold from 50 to 60 hp. For analytical studies, added notes for who performs and deletion (1.1.B.3, 3.4). Clarification on lightning arresters. Other minor rewording. |

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.  This Document must also be edited to delete specification requirements for processes, items, or designs that are not included in the project -- and specifier’s notes such as these.  Additional tailoring requirements are contained in ESM [Chapter 1](http://engstandards.lanl.gov/ESM_Chapters.shtml#esm1) Section Z10 Att. F, Specifications.

To seek a variance from requirements in the specifications that are applicable, contact the Engineering Standards Manual Electrical[POC](http://engstandards.lanl.gov/POCs.shtml). Please contact POC with suggestions for improvement as well.  
  
When assembling a specification package, include applicable Sections from all Divisions, especially Division 1, General requirements.  
  
Section developed for 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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Use the graded approach outlined in the following table (based on ESM Ch. 7, D5000 on Acceptance Testing) to determine if formal electrical acceptance testing as described in this Section is required for specific electrical systems or components.

1. If the indicated threshold is not exceeded for a system or component type, then formal electrical acceptance testing as described in this Section is not required for the specific electrical system or component. Still required would be the Subcontractor- or equipment manufacturer-performed field inspections and tests described in the Section specific to that system or equipment.
2. If the indicated threshold is exceeded for a system or component type, then that system must receive formal electrical acceptance testing and inspections in accordance with this Section using the current edition of NETA ATS–*Acceptance Testing Specification*.
3. ESM Chapter 15 Commissioning and Chapter 16 IBC Program, or other Specification Sections, may require additional test and inspections that are beyond the scope of this Section; coordinate the tests required in this Section with any Test and Inspection Plan (TIP) that may be developed for the Project.
4. Select the appropriate entity to serve as the Electrical Testing Agency (ETA). LANL’s Startup and Commissioning Group (STUPCOMM) may have adequate qualifications, experience, and resources. On larger or complex projects, the services of a LANL-procured (independent of constructor), qualified electrical testing firm may be necessary.

The LANL MSS-CE Low Voltage Electrical Equipment Maintenance (LVEEM) testing crew has the capability to perform testing of equipment (all MLs) that is covered in O&M Criterion 504, *Low Voltage Electrical Equipment*. [MSS Documents: O&M Criterion](https://logistics.lanl.gov/MSS/_layouts/15/start.aspx#/Policy  Procedures/Forms/Public.aspx).

1. If formal electrical acceptance inspection and testing is required for one or more systems or component types, then it may be cost-effective to use the ETA to perform acceptance inspection and testing on the other electrical systems and components addressed by the NETA ATS.

**Thresholds for Formal Electrical Acceptance Inspection and Testing**

| **NETA ATS Clause** | **System or Component Type (Note 1)** | | **Threshold for:**   * **ML-1 SSCs** * **ML-2 SSCs** | **Threshold for:**   * **ML-3 SSCs (Note 4)** * **ML-4 SSCs** | **Notes** |
| --- | --- | --- | --- | --- | --- |
| 7.1 | Switchgear and Switchboards | |  |  |  |
|  |  | Medium-Voltage Switchgear | Any | Any | 2 |
|  |  | Low-Voltage ANSI Switchgear | Any | Any |  |
|  |  | Low-Voltage NEMA Switchboards | Any | > 800 A Main Bus |  |
| 7.2 | Transformers | |  |  |  |
|  |  | Low-Voltage, Dry-Type | Any | >500 kVA Rating |  |
|  |  | Medium-Voltage, Dry-Type | Any | Any | 2 |
|  |  | Liquid-Filled | Any | Any | 2 |
| 7.3 | Cables | |  |  |  |
|  |  | Low-Voltage | Any | > 800 A Circuit |  |
|  |  | Medium- and High-Voltage | Any | Any | 2 |
| 7.4 | Metal-Enclosed Busways | | Any | > 800 A Rating |  |
| 7.5 | Switches | |  |  |  |
|  |  | Low-Voltage | Any | > 800 A Rating |  |
|  |  | Medium- or High-Voltage | Any | Any | 2 |
| 7.6 | Circuit Breakers | |  |  |  |
|  |  | Low-Voltage Molded Case | Any | > 800 A Frame |  |
|  |  | Low-Voltage Insulated Case | Any | Any |  |
|  |  | Low-Voltage Power | Any | Any |  |
|  |  | Medium- or High-Voltage | Any | Any | 2 |
| 7.7 | Circuit Switchers (Medium-Voltage) | | Any | Any | 2 |
| 7.8 | Network Protectors (Low-Voltage) | | Any | Any |  |
| 7.9 | Protective Relays | | Any | Any | 2 |
| 7.10 | Instrument Transformers | | Any | > 800 A Circuit | 3 |
| 7.11 | Metering Devices | | Any | > 800 A Circuit | 3 |
| 7.12 | Regulating Apparatus | | Any | Any | 2 |
| 7.13 | Grounding Systems | |  |  |  |
|  |  | Main Grounding Electrode | Any | N/A |  |
|  |  | System Grounding | Any | N/A |  |
|  |  | Equipment Bonding | Any | N/A |  |
| 7.14 | Ground Fault Protection Systems | | Any | > 800 A Circuit |  |
| 7.15 | Rotating Machinery | |  |  |  |
|  | AC Induction Motors and Generators | |  |  |  |
|  |  | Low-Voltage | Any | > 100 HP or 100 kW |  |
|  |  | Medium-Voltage | Any | Any |  |
|  | Synchronous Motors and Generators | |  |  |  |
|  |  | Low-Voltage | Any | Any |  |
|  |  | Medium-Voltage | Any | Any |  |
|  | DC Motors and Generators | | Any | Any |  |
| 7.16 | Motor Control | |  |  |  |
|  |  | Low-Voltage Motor Starters | Any | > 100 HP Motor |  |
|  |  | Medium-Voltage Motor Starters | Any | Any |  |
|  |  | Low-Voltage Motor Control Centers | Any | > 200 HP Connected |  |
|  |  | Medium-Voltage Motor Control Centers | Any | Any |  |
| 7.17 | Adjustable Speed Drive Systems | | Any | > 60 HP Rating |  |
| 7.18 | Direct-Current Systems | |  |  |  |
|  |  | Flooded Cell Lead-Acid Batteries | Any | >100 V or 1 kWh storage |  |
|  |  | Valve-Regulated Lead-Acid Batteries | Any | >100 V or 1 kWh storage |  |
|  |  | Battery Chargers | Any | >100 V or 1 kW output |  |
| 7.19 | Surge Arresters | |  |  |  |
|  |  | Low-Voltage | Any | > 800 A Circuit |  |
|  |  | Medium- and High-Voltage | Any | Any | 2 |
| 7.20 | Capacitors and Reactors | |  |  |  |
|  |  | Low-Voltage | Any | >50 kVAR Rating |  |
|  |  | Medium- and High-Voltage | Any | Any | 2 |
| 7.21 | Outdoor Bus Structures | | Any | Any |  |
| 7.22a | Emergency Systems (Level 1) | |  |  |  |
|  |  | Engine-Generator and Transfer Switch(es) | Any | Any |  |
|  |  | Uninterruptible Power Systems | Any | Any |  |
| 7.22b | Standby Systems (Level 2) | |  |  |  |
|  |  | Engine-Generator and Transfer Switch(es) | Any | >150 kW Generator |  |
|  |  | Uninterruptible Power Systems | Any | >150 kW Rating |  |
| 7.23 | Communications Systems (Reserved) | |  |  |  |
| 7.24 | Automatic Circuit Reclosers and Line Sectionalizers | |  |  |  |
|  |  | Vacuum (Medium-Voltage) | Any | Any | 2 |
|  |  | Oil (Medium-Voltage) | Any | Any | 2 |
| 7.25 | Fiber Optic Cables (Used for Power Systems) | | Any | Any |  |

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| --- | --- |
| Notes: |  |
| 1. | Thresholds for formal electrical acceptance inspection and testing apply on an individual system or component-type basis. |
| 2. | Medium- and high-voltage utility equipment is inspected and tested by the LANL Utilities. Other medium-voltage systems serving large motors or other utilization equipment that are part of the facility shall be inspected and tested by the Electrical Testing Agency. |
| 3. | Metering: Building electrical metering apparatus and associated instrument transformers are inspected and tested by LANL Utilities. Other metering apparatus or instrument transformers that are part of the facility shall be inspected and tested by the Electrical Testing Agency if the threshold is exceeded. |
| 4. | The Design Authority Representative (FDAR) may invoke formal electrical acceptance testing for selected electrical systems or component types at lower thresholds, including when ML-3. |

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1. GENERAL
   1. Section Includes
      1. Key Subcontractor notifications to LANL of equipment availability for LANL-performed acceptance tests, inspections, and system function tests.
      2. LANL-provided services of a qualified Electrical Testing Agency (ETA) to perform the functions described below:
         1. Acceptance tests, inspections, and system function tests of certain electrical systems, equipment, components, and material (SSCs) installed under the scope of this Project; refer to Part 3 of this Section.
         2. System function tests after completion of acceptance tests on certain electrical SSCs installed under the scope of this Project.

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Edit the following paragraphs to suit project requirements; delete if not applicable to the Project. Coordinate with the ESM Chapter 7 Electrical POC. In most cases, the entirety of paragraph 3 should be deleted, as it is the responsibility of the Design Agency, not the testing agency.

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* + - 1. The following power system studies based on the installed electrical SSCs:

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The Project design agent performs a preliminary fault current study during definitive design. \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

* + - * 1. Final short circuit study

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The Project design agent performs a preliminary coordination study during definitive design. The ETA performs the final coordination study based on the installed system and overcurrent protection devices.

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* + - * 1. Final coordination study

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Coordinate with Section 26 0552, *Electrical Identification for Electrical Systems*. With the results from the final short circuit study and the final coordination study, the ETA has the best available information for performing the arc-flash hazard analysis.

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* + - * 1. Arc-flash hazard analysis

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* + - * 1. Load flow analysis study

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Stability analysis is required for electrical distribution systems with on-site co-generation and/or large synchronous motors.

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* + - * 1. Stability study

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Harmonic analysis is required for electrical distribution systems with harmonic generating non-linear loads (UPS, adjustable frequency drive, power converter, etc.) constituting more than 25‑30% of the connected load.

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* + - * 1. Harmonic analysis study
  1. REGULATORY REQUIREMENTS
     1. Perform inspections and tests in accordance with the following codes and standards:
        1. InterNational Electrical Testing Association - NETA ATS-[current edition], Acceptance Testing Specifications (ANSI). NETA ATS forms a part of this Specification to the extent referenced.
  2. QUALITY ASSURANCE
     1. The ETA shall be independent of the subcontractors installing the equipment (thus, the LANL Start-up and Commissioning Group or a first-tier subcontractor engaged by LANL).

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LANL’s Startup and Commissioning Group (STUPCOMM) may have adequate qualifications, experience, and resources to perform the electrical acceptance testing. (Contact STUPCOMM to determine for this Project.) On large or complex projects, the services of an external, qualified electrical testing firm subcontracted by LANL may be necessary.

LANL’s LVEEM testing crew in MSS-CE can perform testing of equipment covered in O&M Criterion 504, *Low Voltage Electrical Equipment* (all MLs).

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* + 1. The ETA shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
    2. The ETA shall have a documented quality assurance program, documented inspection and test and procedures, and a documented electrical safety program.
    3. The ETA shall have successfully completed not less than five acceptance testing, inspection, and calibration projects of similar scope to this project.
    4. The ETA shall have a calibration program, and test instruments used, for measurements that require calibration, shall be calibrated in accordance with NETA ATS.
    5. ETA technicians performing testing, inspection, calibration, and adjustments shall be:
       1. Trained and experienced concerning the apparatus and systems being evaluated.
       2. Capable of conducting the tests with awareness of the hazards involved and the appropriate safety-related work practices.
       3. Qualified to evaluate the test data and make a judgment on the serviceability of the specific equipment.
    6. Testing, inspection, calibration, and adjustments shall be performed or supervised on the Project site by an ETA employee with one of the following minimum qualifications:
       1. An engineering technician certified to at least Level III in accordance with ANSI/NETA ETT *Standard for Certification of Electrical Testing Technicians* (ANSI), or
       2. An engineering technician certified to at least the NICET ET-grade in Electrical Testing Engineering Technology, or
       3. For (a) ML-3 and ML-4 SSCs and/or (b) LANL personnel-performed testing: An engineering technician certified by the ETA’s internal training/qualification program. As part of the submittal of qualifications, ETA must provide material demonstrating that its certification program is at least equivalent to ANSI/NETA ETT Level III and that the on-site technician’s training and certification is up to date.
  1. ACTION SUBMITTALS
     1. Submit the following in accordance with [Section 01 3300](http://www.lanl.gov/f6stds/pubf6stds/conspec/htmls/csindex.htm) Submittal Procedures:
        1. Certifications: Name and qualifications of the ETA.
        2. Certifications: Quality assurance program of the ETA.
        3. Certifications: Instrument calibration program of the ETA.
        4. Certifications: Electrical safety program of the ETA.
        5. Certifications: Submit name and qualifications of the lead engineer or engineering technician performing the required testing services.
        6. Test Plans: Acceptance and system functions test plan for each item of equipment or system to be field tested at least 45 days prior to planned testing date. Include applicable procedures, forms, and lists of test equipment. Do not perform testing until test plan and procedures have been approved.
        7. Test Reports: Certified copies of inspection reports, test reports, and system function tests. Reports shall include certification of compliance with specified requirements including test instrument calibration, identification of deficiencies, and recommendation of corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test report not more than 10 days after each test is completed.

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Edit the following paragraphs to suit project requirements; delete if not applicable to the Project. Refer to the power system descriptions in Article 1.1. \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

* + - 1. Calculations: Submit certified copies of power system studies listed below. Calculations shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate.
         1. Final short circuit study
         2. Final coordination study
         3. Arc-flash hazard analysis
         4. Load flow study
         5. Stability study
         6. Harmonic analysis.
  1. Coordination
     1. Schedule the project to allow adequate time for electrical acceptance testing BEFORE equipment or system is energized.
        1. Notify the ETA when equipment becomes available for acceptance inspections and tests.
        2. Coordinate work to expedite inspections and tests.
     2. Notify the LANL Subcontract Technical Representative (STR) at least 14 days in advance scheduled acceptance tests, inspections, and system function tests.
        1. Notify the LANL STR again approximately 24 hours before start of testing.
        2. The LANL STR will arrange for witnessing of the tests and inspections by appropriate LANL personnel when required by the Test & Inspection Plan, the applicable codes and consensus standards, or when deemed appropriate by the LANL Design Authority.

1. PRODUCTS

Not Used

1. EXECUTION
   1. GENERAL
      1. Perform the installation insulation-resistance, continuity, and rotation tests for electrical SSCs described in each Section of these Specifications before, and in addition to, tests performed by the ETA that are specified in this Section.
      2. Supply one set of the following to ETA prior to the performance of any final testing:
         1. Preliminary short-circuit analysis.
         2. Preliminary coordination study and protective device setting table.
         3. Complete set of electrical Drawings, Specifications, and any pertinent Change Orders.
         4. Approved construction submittal documents for material and equipment.
         5. Site specific hazard notification and safety training.
         6. Other information necessary for a safe and accurate test and inspection of the system.
   2. INspection and Test Procedures
      1. The ETA shall use test methods, follow procedures, and evaluate test values in accordance with the applicable sections of the NETA ATS, the manufacturer's recommendations, and each applicable specification section.
      2. Tests identified as optional in NETA ATS are not required unless specified.
      3. The ETA shall perform acceptance tests and inspections on electrical SSCs as identified in the following paragraphs. Perform tests and inspections as specified in the applicable clauses of the NETA ATS and as modified by the following paragraphs:

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Edit the following paragraphs to match Project requirements, the construction specifications, and the Management Levels for the Project SSCs. Delete paragraphs pertaining to SSCs not included in the Project. If necessary, add references to new specification sections for SSCs on the Project for which NETA-ATS has a test/inspection procedure. Note any of the NETA-ATS optional inspections/tests that by Project conditions may make necessary. Identify any ML-3 systems or component types for which the Design Authority Representative has invoked more rigorous electrical acceptance testing requirements. Chapters 15 and 16 of the LANL ESM or other Specification Sections may require additional test and inspections that are beyond the scope of this Section; coordinate the tests required in this Section with any Test and Inspection Plan that may be developed for the Project.

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* + - 1. Section 26 0519 – *Low Voltage Electrical Power Conductors and Cables.*
         1. Test low-voltage conductors using the graded approach indicated in Table 1 below.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TABLE 1 - Low Voltage Electrical Power Conductors  (Management Level/ML as determined by AP-341-502) | * ML-1 SSCs * ML-2 SSCs | | | | | * ML-3 SSCs * ML-4 SSCs | | | | |
| Conductor Type/Size/Rating  Inspection or Test per NETA ATS | Service | Feeder | Branch ≥6 AWG | Branch <6 AWG | Control ≥ 120V | Service >800 A | Feeder > 800 A | Branch ≥6 AWG | Branch <6 AWG | Control ≥ 120V |
| Compare conductor data with drawings and specifications. | X | X | X | X | X | X | X |  |  |  |
| Inspect for physical damage and correct connections. | X | X | X | X | X | X | X |  |  |  |
| Inspect connections for high resistance. | X | X | X | X | X |  |  |  |  |  |
| Inspect compression applied connections for correct cable match and indentation. | X | X | X | X | X | X | X |  |  |  |
| Inspect for correct identification and arrangements. | X | X | X | X | X | X | X |  |  |  |
| Inspect jacket insulation. | X | X | X | X | X | X | X |  |  |  |
| Test connections for high resistance using low-resistance ohmmeter. | X | X | X | X | X |  |  |  |  |  |
| Perform insulation-resistance test on each conductor to ground and other conductors. | X | X | X | X | X | X | X |  |  |  |
| Perform continuity tests to insure correct connections. | X | X | X | X | X |  |  |  |  |  |
| Verify uniform resistance of parallel conductors. | X | X | X |  |  |  |  |  |  |  |

* + - 1. Section 26 0526 – *Grounding and Bonding for Electrical Systems.*
         1. Medium-voltage systems: Visually inspect grounding and bonding for each system and circuit. LANL will inspect grounding and bonding of medium-voltage utility systems and circuits.
         2. ML-1 or ML-2 [or ML-3] low-voltage systems: Visually inspect bonding for each system and circuit.
         3. ML-4 [or ML-3] low-voltage systems: Visually inspect grounding and bonding for each system and circuit rated more than 800 amperes.
      2. Section 26 2213 – *Low Voltage Distribution Transformers*
         1. ML-1 or ML-2 [or ML-3] transformers: Test each transformer.
         2. ML-4 [or ML-3] transformers: Test each transformer rated more than 500 kVA.
      3. Section 26 2300 – *Low-Voltage Switchgear*
         1. Test each low-voltage switchgear assembly.
         2. Test each circuit breaker in each low-voltage switchgear assembly.
      4. Section 26 2413 – *Switchboards*
         1. ML-1 or ML-2 [or ML-3] switchboards: Test each switchboard and each included circuit breaker.
         2. ML- 4 [or ML-3] switchboards: Test each switchboard rated more than 800 amperes. Test each included insulated case circuit breaker and power circuit breaker. Test included molded-case circuit breakers using the graded approach indicated in Table 2 of this Section.
      5. Section 26 2416 – *Panelboards*
         1. ML-1 or ML-2 [or ML-3] panelboards: Test each panelboard and each included circuit breaker.
         2. ML- 4 [or ML-3] panelboards: Test each panelboard rated more than 800 amperes. Test included molded-case circuit breakers using the graded approach indicated in Table 2 of this Section.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| TABLE 2 - Molded Case Circuit Breakers  (Management Level/ML as determined by AP-341-502) | | * ML-1 SSCs * ML-2 SSCs | | * ML-3 SSCs * ML-4 SSCs | | | |
| Circuit Breaker Type/Size  Inspection or Test per NETA ATS | | Main C/B | Feeder C/B | Branch Circuit C/B | C/B >800 A Frame | If C/B is part of a switchboard, panelboard, MCC or busway rated >800 A. | | | |
| C/B ≥400 A Frame | | C/B ≥150A Frame | C/B <150A Frame |
| Compare nameplate data with drawings and specifications | | X | X | X | X | X | | X | X |
| Inspect physical and mechanical condition. | | X | X | X | X | X | | X | X |
| Inspect anchorage and alignment. | | X | X | X | X | X | | X |  |
| Verify the unit is clean. | | X | X | X | X | X | | X |  |
| Operate the circuit breaker to assure smooth operation. | | X | X | X | X | X | | X |  |
| Inspect connections for high resistance. | | X | X | X |  |  | |  |  |
| Inspect compression applied connections for correct cable match and indentation. | | X | X | X | X | X | | X |  |
| Measure resistance through connections with a low-resistance ohmmeter. | | X | X | X | X | X | |  |  |
| Measure insulation-resistance on each pole phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole. | | X | X | X | X | X | |  |  |
| Measure contact/pole resistance. | | X | X | X | X | X | |  |  |
| Perform insulation resistance tests on all control wiring, | | X | X | X |  |  | |  |  |
| Perform adjustments for final setting in accordance with coordination study. | | X | X | X | X | X | |  |  |
| Determine long-time pickup and delay by primary current injection. | | X | X | X | X | X | |  |  |
| Determine short-time pickup and delay by primary current injection. | | X | X |  | X | X | |  |  |
| Determine ground fault pickup and delay by primary current injection. | | X | X | X | X | X | |  |  |
| Determine instantaneous pickup by primary current injection. | | X | X | X | X | X | |  |  |
| Verify correct operation of auxiliary functions. | | X | X | X | X | X | |  |  |

* + - 1. Section 26 2419 – *Motor Control Centers*
         1. ML-1 or ML-2 [or ML-3] motor control centers: Test each motor control center and each included circuit breaker. Verify that motor overload protection in each controller is appropriate for the application.
         2. ML- 4 [or ML-3] motor control centers: Test each motor control center with more than 200 hp total connected load. Test included molded-case circuit breakers using the graded approach indicated in Table 2 of this Section. Verify that motor overload protection in each controller is appropriate for the application.
      2. Section 26 2500 – *Enclosed Bus Assemblies*
         1. ML-1 or ML-2 [or ML-3] enclosed bus assemblies: Test each enclosed bus assembly and each associated bus plug circuit breaker.
         2. ML- 4 [or ML-3] enclosed bus assemblies: Test each enclosed bus assembly rated more than 800 amperes. Test associated bus plug molded case circuit breakers using the graded approach indicated in Table 2 of this Section.

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Metering is tested by LANL Utilities. Delete paragraph 9 unless LANL-UI requests for it to be included in this Section.

In paragraph 13, Level 1 is equivalent to NEC Art. 700 Emergency. Level 2 is equivalent to NEC Art. 701 Legally required standby. Optional standby, NEC Art. 702, is not covered and is not required to be tested.

* + - 1. Section 26 2713 – *Electricity Metering*
         1. LANL will inspect, test, adjust, and program metering installed under Section 26 2713.
         2. ML-1 or ML-2 [or ML-3] low-voltage systems: Test metering for each system and circuit.
         3. ML- 4 [or ML-3] low-voltage systems: Test metering for each system and circuit rated more than 800 amperes.
      2. Section 26 2816 – *Enclosed Switches and Circuit Breakers*
         1. ML-1 or ML-2 [or ML-3] enclosed switches and circuit breakers: Test each enclosed switch and circuit breaker.
         2. ML-4 [or ML-3] enclosed switches and circuit breakers: Test each enclosed switch rated greater than 800 amperes. Test enclosed molded case circuit breakers using the graded approach indicated in Table 2 of this Section.
      3. Section 26 2913 – *Enclosed Controllers*
         1. ML-1 or ML-2 [or ML-3] enclosed controllers: Test each enclosed controller. Verify that motor overload protection is appropriate for the application.
         2. ML-4 [or ML-3] enclosed controllers: Test each enclosed controller supplying a motor larger than 100 hp. Verify that motor overload protection is appropriate for the application.
      4. Section 26 2923 – *Variable Frequency Motor Controllers*
         1. ML-1 or ML-2 [or ML-3] variable frequency motor controllers or adjustable speed drive systems: Test each variable frequency motor controller or adjustable speed drive system.
         2. ML-4 [or ML-3] variable frequency motor controllers or adjustable speed drive systems: Test each variable frequency motor controller or adjustable speed drive system supplying a motor larger than 60 hp.
      5. *Engine-Generators*
         1. ML-1 or ML-2 [or ML-3] engine-generator systems: Test each engine-generator system.
         2. ML-4 [or ML-3] engine-generator systems:

1. Test each NFPA 110 Level 1 engine-generator system.
2. Test each NFPA 110 Level 2 engine-generator system rated more than 150 kW.
   * + 1. Section 26 3353 – *Static Uninterruptible Power Supply*
          1. ML-1 or ML-2 [or ML-3] uninterruptible power supplies: Test each UPS.
          2. ML-4 [or ML-3] uninterruptible power supplies:
3. Test each NFPA 111 Level 1 UPS.
4. Test each NFPA 111 Level 2 UPS rated more than 150 kW.
   * + 1. *Automatic Transfer Switches*
          1. ML-1 or ML-2 [or ML-3] automatic transfer switches: Test each automatic transfer switch.
          2. ML-4 [or ML-3] automatic transfer switches:
5. Test each automatic transfer switch associated with an NFPA 110 Level 1 engine-generator system.
6. Test each automatic transfer switch associated with an NFPA 111 Level 1 UPS system.
7. Test each automatic transfer switch associated with an NFPA 110 Level 2 engine-generator system rated more than 150 kW.
8. Test each automatic transfer switch associated with an NFPA 111 Level 2 UPS system rated more than 150 kW.

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Edit the following paragraphs to match Project requirements and the Specification.

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* + 1. Tests and inspections on the following equipment and systems will be performed by either the installing firm or LANL and are excluded from the scope of this Section:
       1. Addressable fire alarm system
       2. Administrative access control system
       3. Instrumentation and controls systems
       4. Lightning protection system
       5. Medium-voltage utility power cable
       6. Pad-mounted medium-voltage utility switchgear
       7. Pad-mounted utility transformer with medium-voltage primary
       8. Electricity metering
       9. Security system
       10. Telecommunications system
       11. Voice paging system

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Edit the following paragraphs to match Project requirements and the construction Specification for the Project. Delete paragraphs pertaining to SSCs not included in the Project. If necessary, add references to new specification sections for equipment/systems on the Project for which NETA-ATS has a test/inspection procedure.

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* 1. System Function Tests
     1. The ETA shall develop and perform system function tests on the following SSCs in accordance with NETA ATS after completion of the inspection and test procedures described above.
        1. Section 26 2300 – *Low-Voltage Switchgear*
           1. Verify proper function of key interlock systems.
           2. Verify proper function of main-tie-main automatic throw-over system,
           3. Verify proper operation of zone-selective interlock system.
           4. Verify proper operation of arc-flash reduction maintenance switch.
           5. Verify proper operation of internal communications network.
           6. Verify proper operation of interfaces with building automation system.
        2. Section 26 2413 – *Switchboards*
           1. Verify proper operation of zone-selective interlock system.
           2. Verify proper operation of arc-flash reduction maintenance switch.
           3. Verify proper operation of interfaces with building automation system.
        3. Section 26 2416 – *Panelboards*
           1. Verify proper operation of interlock and shunt trip systems.
        4. Section 26 2419 – *Motor Control Centers*
           1. Verify proper operation of interfaces with building automation system.
           2. Verify proper operation of interlock systems.
        5. Section 26 2816 – *Enclosed Switches and Circuit Breakers*
           1. Verify proper operation of interlock and shunt trip systems.
        6. Section 26 2913 – *Enclosed Controllers*
           1. Verify proper operation of interfaces with building automation system.
           2. Verify proper operation of interlock systems.
        7. Section 26 2923 – *Variable Frequency Motor Controllers*
           1. Verify proper operation of interfaces with building automation system.
           2. Verify proper operation of interlock systems.
        8. Section 26 3353 –*Static Uninterruptible Power Supply*
           1. Verify proper operation of interfaces with building automation system.
           2. Verify proper operation of interlock systems.
           3. Verify proper operation of external maintenance bypass system.

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Edit the following article to suit project requirements. Delete power systems that are not applicable to the project. Refer to the power system studies described in Article 1.1. In most cases, the entirety of Article 3.4 will be deleted since this is performed by the design agency.

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* 1. POWER SYSTEM STUDIES
     1. The ETA shall provide power system studies described below based on the installed electrical distribution system and equipment in accordance with procedures described in NETA-ATS and the referenced codes and standards.
        1. Include in the study the effect of all portions of the electrical distribution system including alternate sources of power.
        2. Address normal system operating configuration plus any plausible alternate configurations and operations that could result in maximum fault condition.
     2. Final Short-Circuit Study. Perform final short-circuit calculations using procedures outlined in IEEE Std 242.
        1. As a minimum, calculate the short-circuit momentary and interrupting duty based on maximum available fault current at each bus in the distribution system down to the following points in the low-voltage system:
           1. 480-volt system where available short circuit current is less than 14,000 amperes RMS symmetrical.
           2. 208- or 240-volt system where available short circuit current is less than 10,000 amperes RMS symmetrical.
        2. Include on-site emergency power systems and standby power systems if present.
        3. Include, if present, battery systems with storage capacity greater than 1 kWh or a float-voltage greater than 100 volts.
        4. Extend the short-circuit study to include the branch-circuit overcurrent protective devices for the following systems if present:
           1. Safety Class Systems
           2. Safety Significant Systems
           3. Emergency Systems (NEC Article 700)
           4. Legally required Standby Systems (NEC Article 701)
           5. Critical Operations Power Systems (NEC Article 708).
     3. Final Coordination Study. Perform final coordination study using procedures outlined in IEEE Std 242.
        1. As a minimum, include in the coordination study all voltage classes of equipment from the utility incoming line protective device(s) down to and including each low voltage load protective rated 100 amperes and larger.
        2. Include on-site emergency power systems and standby power systems if present.
        3. Include, if present, battery systems with storage capacity greater than 1 kWh or a float voltage greater than 100 volts.
        4. Extend the coordination study to include the branch-circuit overcurrent protective devices for the following systems if present:
           1. Safety Class Systems
           2. Safety Significant Systems
           3. Emergency Systems (NEC Article 700)
           4. Legally required Standby Systems (NEC Article 701)
           5. Critical Operations Power Systems (NEC Article 708)
     4. Arc-Flash Hazard Analysis. Perform arc-flash hazard analysis and shock hazard analyses based on the final short-circuit study and the final coordination study. Use procedures outlined in IEEE Std 1584 and NFPA 70E. Provide the following information in tabular form for the arc-flash warning labels described in Section 26 0553, *Identification for Electrical Systems*:
        1. Flash hazard boundary (inches) calculated in accordance with IEEE Std 1584 or NFPA 70E.
        2. Arc-flash incident energy (cal/cm2) calculated in accordance with IEEE Std 1584 or NFPA 70E.
        3. Working distance (inches) selected from IEEE Std 1584 or NFPA 70E (Annex D) based on equipment type.
        4. Hazard/risk category number from NFPA 70E Table 130.7(C)(9) for operations with doors closed and covers on.
        5. System phase-to-phase voltage.
        6. Condition that exposes worker to electrical shock hazard.
        7. Limited Approach Boundary from NFPA 70E Table 130.2(C) based on nominal system phase-to-phase voltage.
        8. Restricted Approach Boundary from NFPA 70E Table 130.2(C) based on nominal system phase-to-phase voltage.
        9. Class for insulating gloves based on system voltage (e.g., Class 00 for up to 500 volts).
        10. Voltage rating for insulated or insulating tools based on system voltage (e.g., 1000 volts).
        11. Equipment ID code based on Drawings and including TA number, building number, and system identifier.
        12. Date that hazard analysis was performed.
        13. “Served from” circuit directory information including the serving equipment ID code, location (e.g., room number), circuit number, and circuit voltage/phases/wires.
        14. If applicable, “serves” circuit directory information including the served equipment ID code, location (e.g., room number), circuit number, and circuit voltage/phases/wires.
     5. Load Flow Study. Perform load flow study using procedures outlined in IEEE Std 399.
     6. Stability Study. Perform stability study using procedures outlined in IEEE Std 399.
     7. Harmonic Analysis Study. Perform harmonic analysis study using procedures outlined in IEEE Std 399.
  2. Test Report
     1. The ETA shall include the following information in the final test report:
        1. Summary of project.
        2. Description of equipment inspected and tested.
        3. Description of inspections and tests.
        4. Data record resulting from each inspection and test.
        5. Results of system function tests.
        6. Power system studies.
        7. Analysis of the tests, identification of deficiencies, and recommendations for corrective action.
     2. Include the following minimum information in each data record:
        1. Identification of the ETA.
        2. Equipment identification: Equipment ID code based on Drawings and including TA number, building number, and system identifier.
        3. Humidity, temperature, and other conditions that may affect the results of the tests or calibration of test equipment.
        4. Date inspection, test, or function test was performed.
        5. Identification and signature of the testing technician.
        6. Description of inspections, tests, maintenance, and function tests performed and recorded.
        7. Test equipment used and references to calibration records.
        8. Indication of as-found condition and as-left results.
     3. Submit six copies of the complete report to the LANL STR.
  3. Field Quality Control
     1. Report to the LANL STR, within three working days, any SSC or construction that is found defective based on acceptance tests or inspections by the ETA.
     2. Within 15 days of direction from the LANL STR, rework, repair or replace any SSC or construction that is found defective based on acceptance tests or inspections.
     3. The ETA shall retest any SSC or construction that did not pass acceptance tests or inspections.

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 26 0813 Rev. 3, dated July 6, 2022.